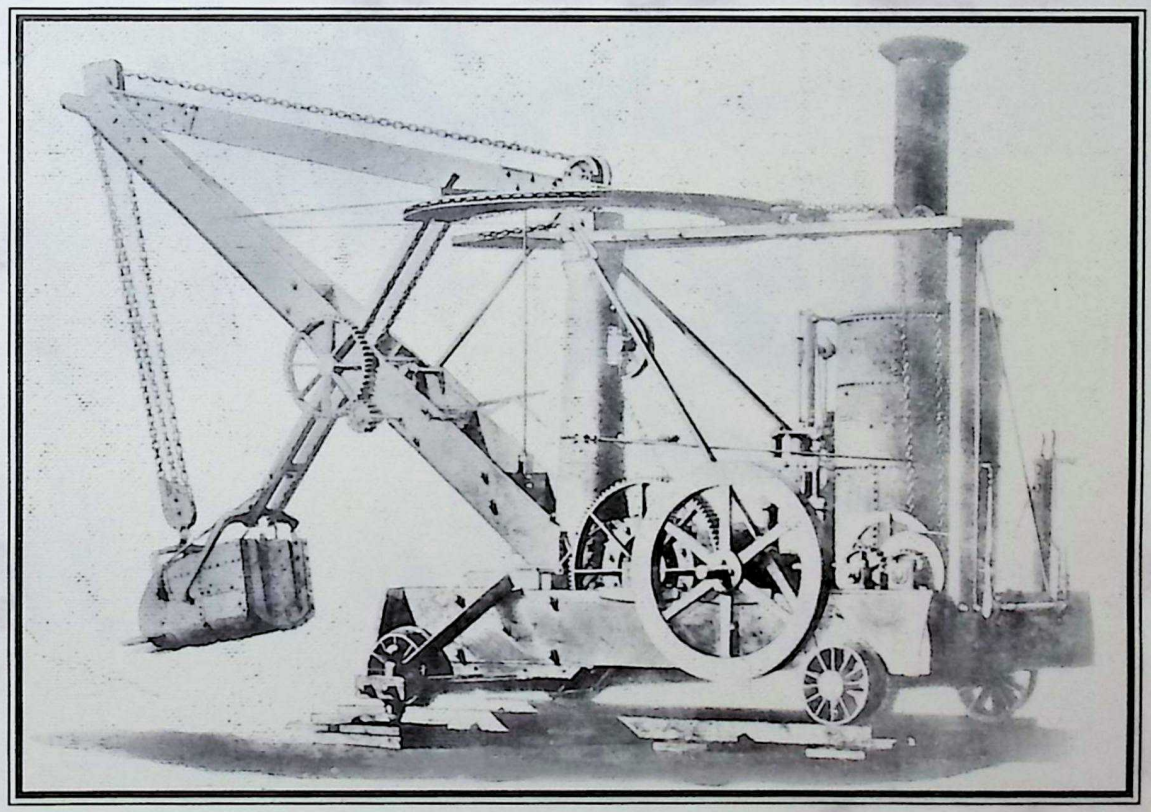
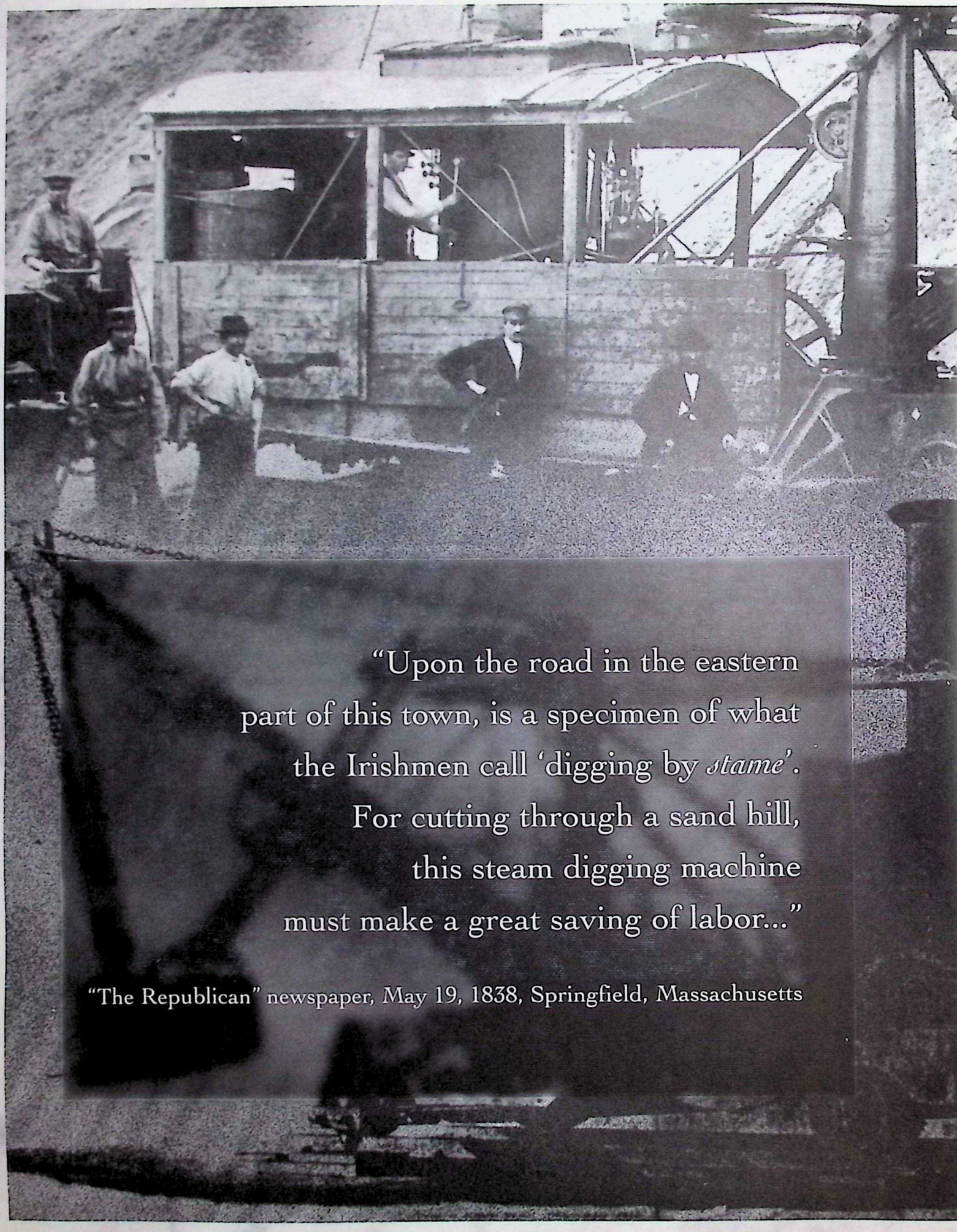
DIGGING BY "STAME"

A history of the first steam shovels.



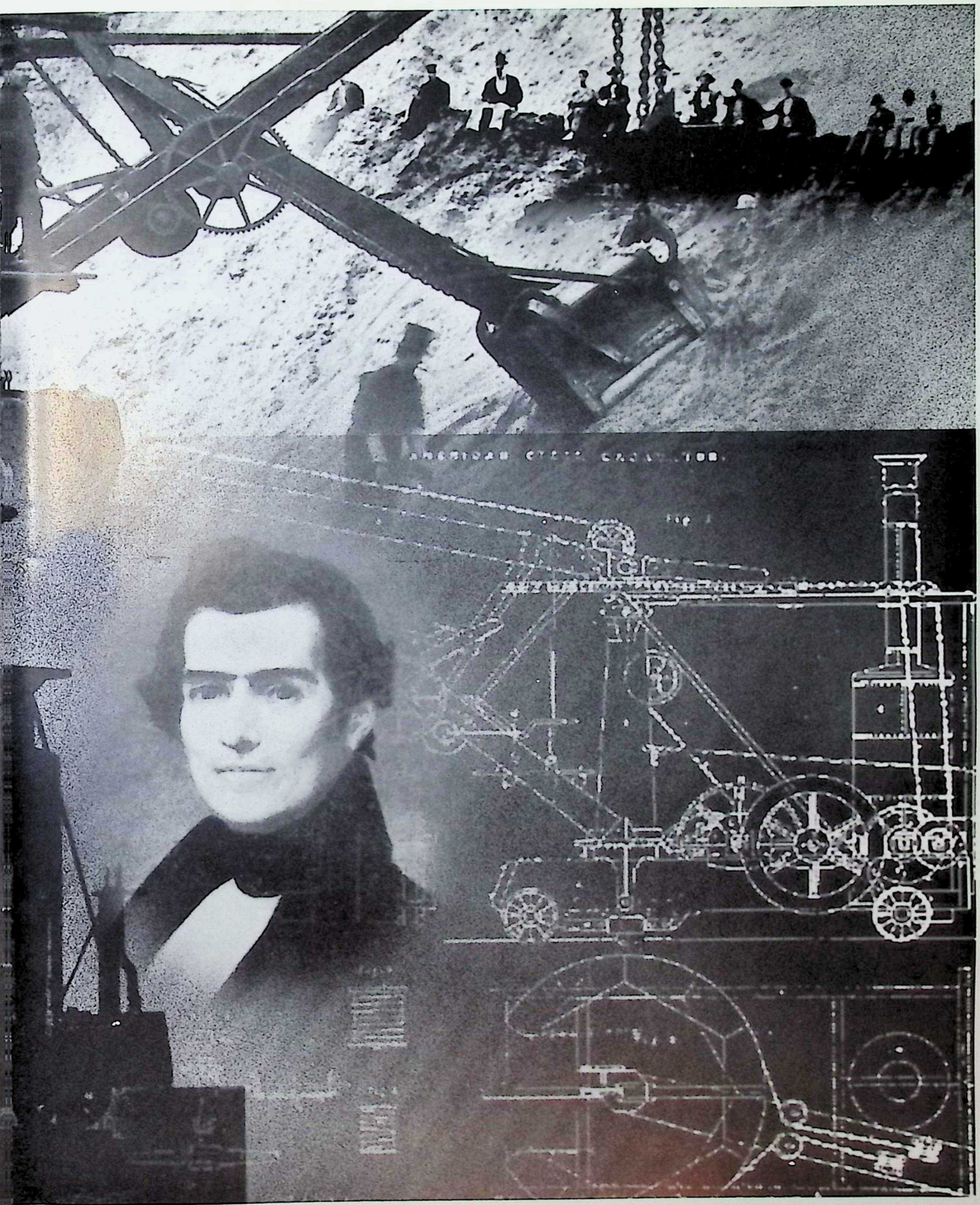
by William E. Farrell

(Edited and reprinted by the Historical Construction Equipment Association)



"Upon the road in the eastern
part of this town, is a specimen of what
the Irishmen call 'digging by *steame*'.
For cutting through a sand hill,
this steam digging machine
must make a great saving of labor..."

"The Republican" newspaper, May 19, 1838, Springfield, Massachusetts



DIGGING BY "STAME"

by

William E. Farrell

PROPERTY OF
CANTON HISTORICAL SOCIETY
BY _____
DATE ACKD 12-3-1997

Edited and revised by Donald W. Frantz
Reprinted by the Historical Construction Equipment Association

Digging by *"Stame"*
Copyright 1994 all rights reserved by the
Historical Construction Equipment Association
P.O. Box 328, Grand Rapids, Ohio 43522

Cover and frontispiece illustration by Vincent E. Frantz

Introduction

The following is a reprint of an article written by William E. Farrell that first appeared in 1936 in the "Excavating Engineer" magazine. This was the first, and to date, only in-depth look at the birth of the steam shovel and the early evolution of its manufacture and use. The "Excavating Engineer" was a publication evolved from the "Steam Shovel News" and sponsored by the Bucyrus-Erie Company of South Milwaukee, WI, an early manufacturer of steam shovels that remains a supplier of some of the world's largest excavators. The year 1936 represented the 100th anniversary of the invention of the steam shovel by William S. Otis.

This article is reproduced in a revised and edited form from the original. However, only material unrelated to the central theme has been deleted. Since this article was written, several other primary and secondary sources of information have been discovered which tend to clarify and improve the historical accuracy of the original. These are included through the addition of an appendix which is referred to in the body of the article at appropriate places.

The Historical Construction Equipment Association expresses its appreciation to the Bucyrus-Erie Company for its permission to reproduce this article and for the use of material from its historical archives. The Historical Construction Equipment Association, a non-profit organization with world-wide membership, offers this reprint project as an expression of its concern for the preservation of the history of construction, surface mining, and dredging equipment.

I would like to thank HCEA charter members Harry E. Young, II and J. Keith Haddock for their valuable help in supplying supplemental information.

Donald W. Frantz,
HCEA Editor and Managing Director

Digging by "*Stame*"

This account is an effort to tell the story of the early steam shovels and to arouse interest in and due recognition for the inventor, whose originality has contributed so much to the world's economic progress. There are no large and but few small works of construction or excavation on which one or more shovels are not employed.

In 1924, Mr. E.A. Herman made the first comprehensive review of steam shovels in an address before the A.S.C.E., which was later published in book form. His report dealt only with the art and manufacture of the previous ten or fifteen years. It is much to be regretted that with this inspiration a complete early history was not then attempted, as many of those associated with the first shovels were still alive.

In 1924 an article appeared in one of our trade journals on the origin and development of contractors' equipment. Here for the first time an effort was made to describe completely the origin and early use of the steam shovel. The facts given there have served as the basis for all subsequent writings on the subject, without apparent effort to confirm the statements made. The author of that article says that he has unfortunately "long since destroyed his notes and the information from which he made up the article."

Two Patent Applications

That William Smith Otis is the inventor, there is no doubt, although his name is today comparatively unknown. **[See Page 4]** His original application for a patent was filed June 15, 1836, but all the accompanying correspondence, drawings and model were destroyed by fire in the patent office and another application for patent became necessary. The second application was filed October 27, 1838, the patent being allowed February 24, 1839, patent No. 1089. **[See Pages 16-18]**

The original shovel was a success and the modern shovel differs but little from it in basic principle of operation. The motive power has been changed, due to the advent of gasoline and electricity.

With Otis' death at the early age of 26, the development of the shovel, its use in the field of construction, and, we might say, human progress due thereto lay dormant for about 25 years.

The great difference between Otis' idea of a mechanical excavator and all previous conceptions was clearly set forth by a writer who, in 1843 stated its points of superiority to be:

First. ***It is a locomotive, self-propelling.***

Second. ***Earth is broken up and carried away by a single instrument, a scoop.***

Third. ***The machine cuts with equal facility at any inclination to the horizon.***

Fourth. ***By means of this machine a channel can be cut through a hill with proper sloping sides and a level base correctly formed.***

Fifth. ***The capability of the machine for cutting several feet below the base on which it runs.***

These features still distinguish this excavator from all other forms and man's ingenuity in the last hundred years has been unable to conceive of a superior machine for the same purpose.

There was no satisfactory power excavator before Otis' invention. Practically all excavation was by pick, shovel and wheelbarrow. The cost or even the possibility of constructing our highways, railroads, canals, dams, tunnels, excavations for our skyscrapers or loading operations in our mines and quarries, metallic and non-metallic, without the shovel is inconceivable.

With Pick and Shovel

To give some idea of the organizations required in Otis' day on excavations take these quotations:

"For the removal of 28,414 cubic yards of earth there were required 4597 men and 495 horses."

"The progress on this railway was so rapid in 1839 that not less than 450,000 cubic yards were effected per month and the number of men employed amounted to 8600."

For at least twenty years only two shovels were in use in the United States, and none were made abroad until England did so in 1876.

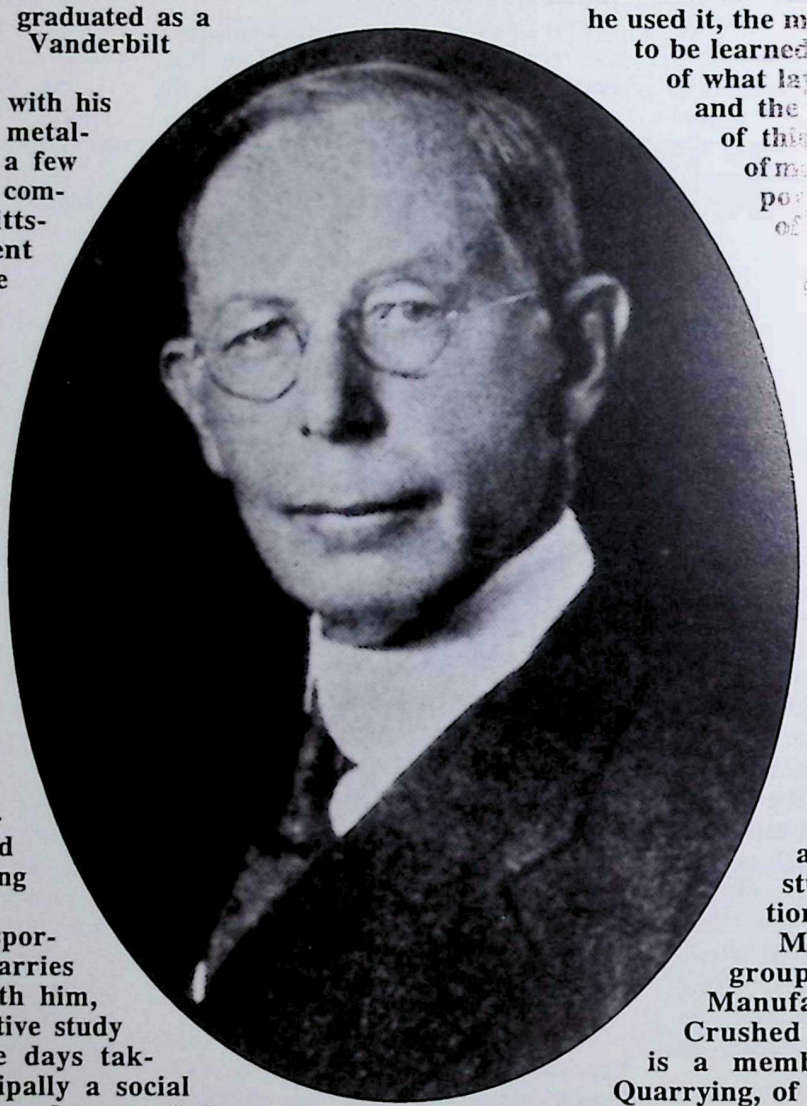
These circumstances may be partly accounted for by the death of the inventor in 1839; because the manufacturers of the shovels went to Russia in 1844, taking with them a large portion of their equipment; and lastly by the desire of the contractors owning the two shovels to possess this advantage over their competitors.

"Steam" vs. "Power" Shovels

While it is technically correct to call the original Otis invention a "steam shovel"; and such it remained until about 1900, when other forms of power were applied to it; it is more correct today to designate it as a "power shovel." Unfortunately, the foreign technical press and manufacturers do not differentiate carefully between the different forms and kinds of power excavators when speaking of the power shovel. A power shovel in the United States is not a skimmer, back digger, trench hoe, crane, clamshell, back filler, dragline, drag shovel or dredge, etc., and yet in the foreign technical press and catalogs, "steam navvy," "pella a vápeur," "pala a vapor" or "loffel-bagger," may be used to designate one or more of the various modifications. Within this article a steam shovel is an excavator intended for operation on land, is driven by steam and has a boom with a dipper rigidly attached to a dipper stick which is **not** hinged.

(Continued on Page 3)

William Elliston Farrell



WILLIAM ELLISTON FARRELL was born in Nashville, graduated as a mining engineer from Vanderbilt University in 1891.

After a European trip with his university professor of metallurgy, Mr. Farrell took a few dollars and some highly complimentary letters to Pittsburgh. When prominent men there declined to be suitably impressed, he returned to teach chemistry at Vanderbilt.

Later, a position as chemist (salary $50 a month) with a blast furnace brought about his return to Pennsylvania, which state has been the center of his business activity ever since. In 1914, Mr. Farrell went into business for himself, as owner and president of the Easton Car and Construction Company, Easton, Pennsylvania, which manufactures industrial car and other material handling equipment.

About 1920, the transportation problem in quarries became an obsession with him, and he began an exhaustive study of the subject. In those days taking "movies" was principally a social stunt, but Mr. Farrell bought one of the best machine he could obtain, and the more he used it, the more he saw how much had to be learned to tell correctly the story of what lay between the quarry face and the crusher. Concrete results of this study came in the form of many improvements in transportation equipment, some of them covered by patents.

A more indirect result of the "movies" taken (a series of them showing handling of stone by steam shovels) was an interest in shovels—which led him to make this study of the origin and early development of the steam excavator.

Several years ago, Mr. Farrell turned over to others the details of his business not pertaining to quarries, and made his headquarters at his New York office where he could best advise with crushed stone producers and pursue his expert study of quarry transportation problems.

Mr. Farrell was one of the group which organized the Manufacturers Division of the Crushed Stone Association, and is a member of the Institute of Quarrying, of England, before which he has delivered several addresses. ■

In 1835, Otis was engaged on a construction contract which his firm Carmichael, Fairbanks and Otis, had with the Boston and Providence Railroad. He made his temporary home at Canton, Massachusetts, and it was there that, with the assistance of a friend, Charles Howe French, who had just completed his apprenticeship, the first "Crane Excavator," as he called the machine in his application, was built. [See Page 9] The phrase "Crane Excavator," used in the patent application conforms well to descriptions of this first shovel, where it is referred to as consisting of two parts, a power plant and a quarry derrick (or crane).

Description of First Shovel

The following description is believed to [illegible] original shovel built by [illegible] French.

[illegible] built along the lines of a quarry derrick, having a mast supported by cables attached to the top and anchored to dead men placed on the ground. The mast was provided with a boom, to which was hinged the end of the dipper handle, making it necessary to raise and lower the boom for each dipper load, similar to the Oswego boom machine. This application was effected by a double drum hoisting engine.

"No mechanical provision was supplied to swing the boom. Therefore, a rope was attached on each side of the boom at the point, and the boom was swung by two men on the ground, one on each side; one of these men tripped the bucket also. The machine was moved ahead in the same manner as a quarry derrick is moved, and in some cases it required half a day to make one move-up. This experimental machine did not prove to be altogether satisfactory; therefore the derrick, boom, dipper, etc., were moved back on to the frame."

The spot where the original crane was built is described as "near the Upper Silk Factory where the Massopoag Brook crosses Shepard Street."

The first shovel was taken to Worcester, Massachusetts, according to the best information available, where it was operated by French in the construction of the Norwich and Worcester Railroad, and the feasibility of excavating by a power shovel fully demonstrated.

This shovel has generally been ignored, and the one built later in Philadelphia called the "first.

After leaving Canton, it was natural that Otis should return to his father's home in Philadelphia and that, having no more permanent home, owing to the nature of his business, he should speak of himself in his application as being a resident of Philadelphia. The Quaker City was also attractive to Otis because of its several well equipped machine shops and skilled mechanics, as he evidently contemplated the building of a shovel more nearly conforming to his conception.

The First Philadelphia Shovel

Otis returned to Philadelphia in 1836 and attempted through his own efforts and without any assistance, to have various parts of the improved shovel as he conceived it

(Continued on Page 5)

[33]

LOCOMOTIVE ENGINES.

EASTWICK & HARRISON,

LOCOMOTIVE AND STATIONARY ENGINE MAKERS,

AND GENERAL MACHINISTS,

North-west corner of James and Twelfth Street,

ON THE WILLOW STREET RAIL ROAD,

PHILADELPHIA,

Are prepared to receive orders for Machinery in their line, which they will engage to execute with promptness, and in a workmanlike manner.

They would particularly call the attention of Rail Road Companies to the improvements they have made in Locomotives, by which either Anthracite Coal or Wood can be used, with perfect facility, in boilers of the ordinary horizontal form. Also, to their eight-wheel Engines, which are admirably adapted to roads having high grades to overcome, and are capable of drawing heavier loads, with less injury to the road, than any other description of Engine of the same weight used in this country.

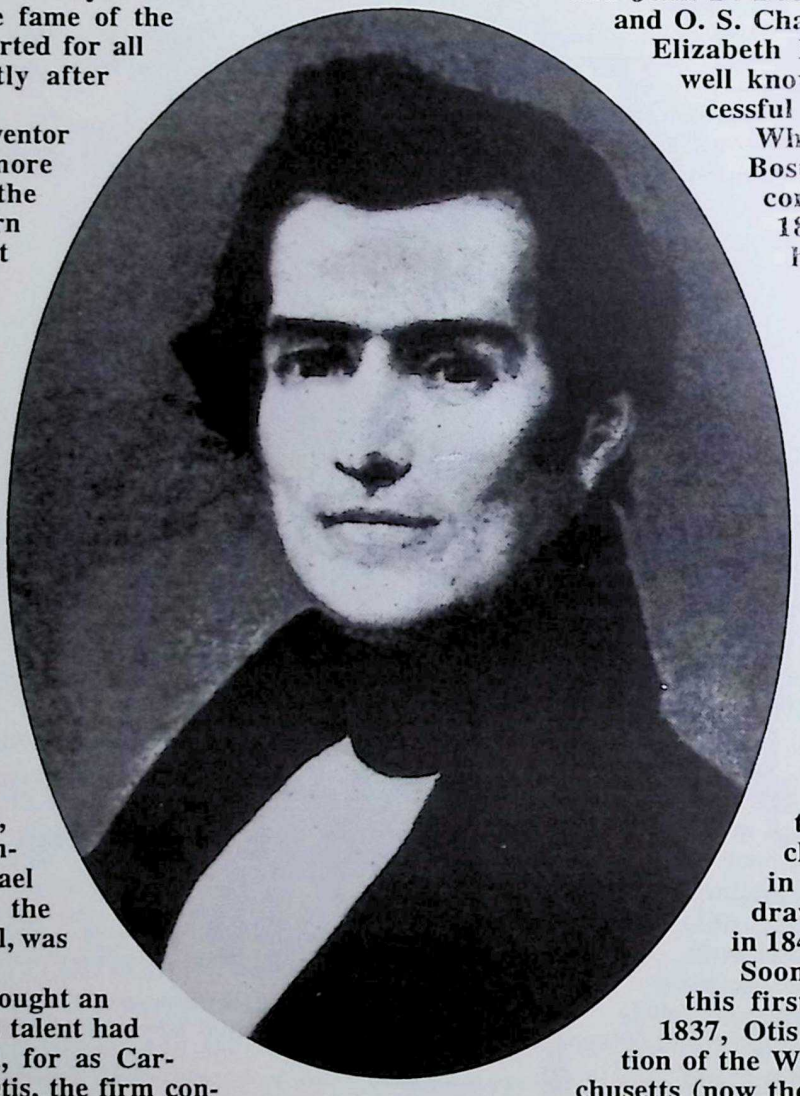
Satisfactory references can be given as to the power and workmanship of their Engines, by those who have used them.

A. M. EASTWICK. JOSEPH HARRISON, Jr.

Fig. 1 The Philadelphia firm of Eastwick & Harrison helped Otis considerably in the building of his first shovel in that city. They were also locomotive and engine makers, as shown by this ad which appeared in 1840.

William Smith Otis

IN 1631 JOHN OTIS emigrated from England and settled at Hingham, Massachusetts. Seven generations later two of his descendants, distantly related, but of the same surname, invented appliances which will ever be of great service to man. While the name of one will always be associated with elevators, the fame of the other seems to have departed for all practical purposes shortly after his death.



William S. Otis, the inventor of the steam shovel (more properly called today the "power" shovel) was born on September 20, 1813 at Pelham, Massachusetts. His father was post-master there, later becoming a contractor in Pennsylvania, and still later president of a New York City bank.

The Otis family moved to Philadelphia when he was about 15 or 16 years old. Of his education and business training, there are no records, though he probably acquired a knowledge and interest in contracting through association with his father. When he was about 20, young Otis joined the contracting firm of Carmichael and Fairbanks, of which the senior partner, Carmichael, was his brother-in-law.

By 1834 he had either bought an interest in the firm, or his talent had merited the same reward, for as Carmichael, Fairbanks and Otis, the firm contracted for the construction of a part of the Boston and Providence Railroad, now known as the New York, New Haven and Hartford.

Otis then lived in Canton, Massachusetts and it was while here, in the year 1835, that his conception of the shovel grew to perfection. With the assistance of his even younger friend, French, a steam shovel was built and actually put in operation by the latter.

But everything was not business for Otis in Canton. On Sunday afternoons he and his young friends often gathered at the home of Deacon Leonard Everett, who had several charming daughters. On June 25, 1835, Otis married one of these daughters, Elizabeth. Later French married another, and John D. Dunbar, a third. These men, and O. S. Chapman, who later married Elizabeth Everett Otis, all became well known as reputable and successful contractors.

When the contract with the Boston and Providence was completed in the fall of 1838, Otis returned with his bride to Philadelphia, possessed with the idea of building another and better steam shovel. There he had a cousin, Rufus S. Mason who was an instructor in drafting, to assist him with his drawings. Although he set to work at first to build the shovel himself, from parts constructed at various machine shops, he soon turned the entire job over to the firm of Garret and Eastwick—later Eastwick and Harrison—and they produced the machine faithfully portrayed in a much photographed drawing which Mason made in 1841.

Soon after the completion of this first Philadelphia shovel, in 1837, Otis used it on the construction of the Western Railroad of Massachusetts (now the Boston and Albany) and it was while so engaged that he died of typhus fever at Westfield, Massachusetts, November 13, 1839 at the early age of 26. While on this Western Railroad job, Otis made and used what was probably the first industrial locomotive—a four ton machine with an up right boiler and an engine with oscillating cylinders.

Two children of Otis died in infancy. His widow married his friend and cousin, O. S. Chapman in 1845. ■

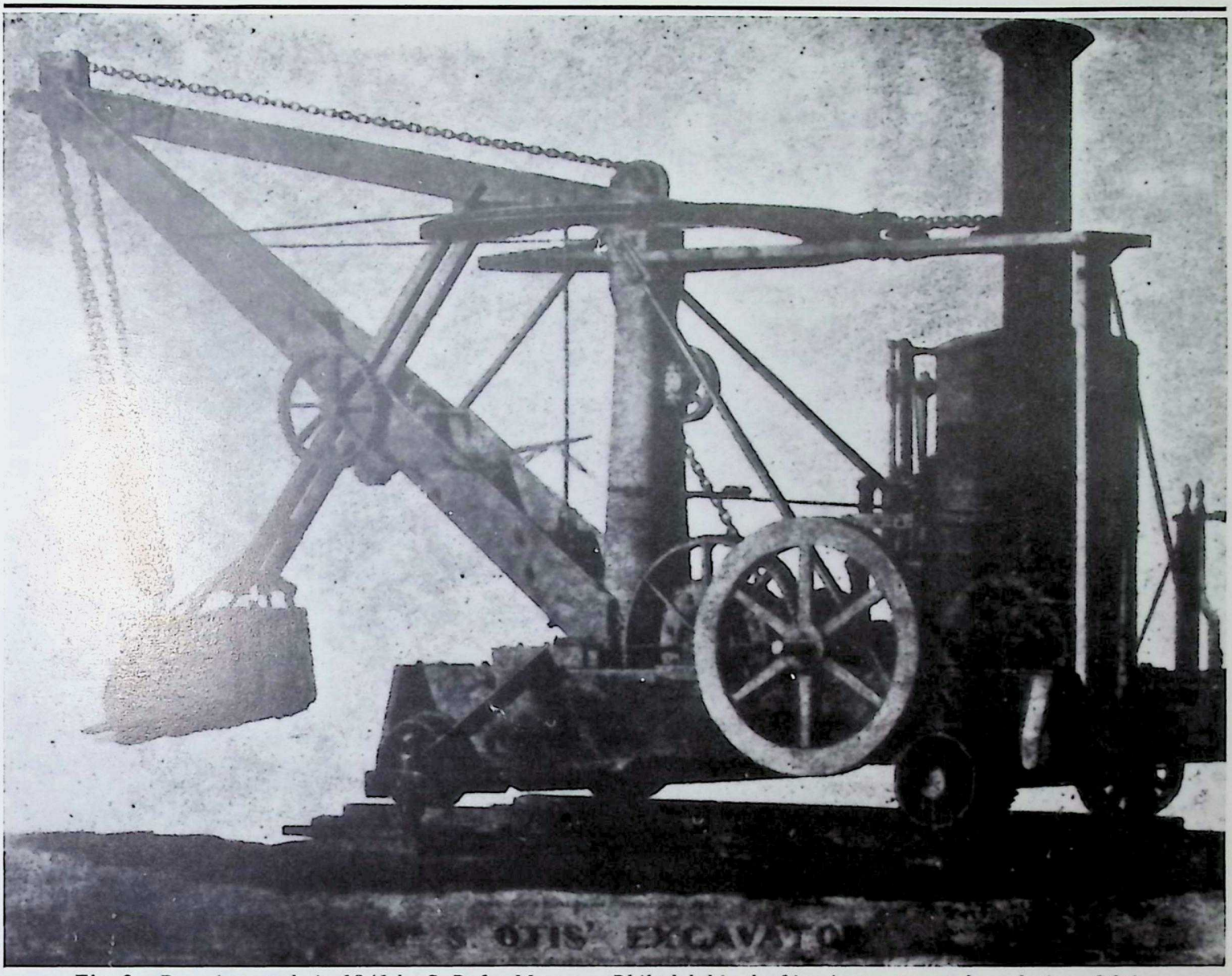


Fig. 2 Drawing made in 1841 by S. Rufus Mason, a Philadelphia drafting instructor and a relative of Otis.

built under his direction in several shops. This attempt proved unsuccessful and he was possibly on the verge of failure, owing to the difficulties arising from this method, when he fortunately became acquainted with the firm of Garret and Eastwick, to whom he brought his several parts and to whom he gave an order to build a complete machine. This firm had a foreman, Joseph Harrison, Jr., of unusual skill and ability, and the perfection of many of the mechanical details, whose solution would be difficult for so young a contractor, doubtless owed much to him. **[See Page 8]**

Harrison soon bought out Garret's interest and became a partner in the firm, which was known afterwards as Eastwick and Harrison. **(Fig. 1)** A visitor to their plant, then located at 12th and Willow Streets, wrote in 1843: "The first of the seven machines was practically completed at various workshops under the direction of Mr. Otis, the inventor; but finding some difficulty in organizing and fitting up so complicated a machine by this method he placed it in the hands of Messrs. Eastwick and Harrison, who skillfully perfected the details and gave such good proportions to the several parts that all the machines constructed, including the experimental one, have proven in practice to be completely successful."

Of the seven machines referred to above, four went to Russia, one to England, and two remained in the United States.

The earliest illustration of the Otis machine, as built by Eastwick and Harrison, was made in 1841 by S. Rufus Mason, a teacher of drafting in Philadelphia, and a relative of Otis. **(Fig. 2)**

Drawings to England

Reproductions of the Mason drawing must have been sent to England, for in March 1843, an illustration of the Otis shovel appeared in print for the first time in the London Journal. This illustration conforms to the Mason drawing in every detail except for the addition of the two operators. **(Fig. 3)**

While the Mason drawing without doubt gives a very clear picture of the first shovels it is in perspective. Fortunately an English publication, desiring to describe in May, 1843, an

(Continued on Page 7)

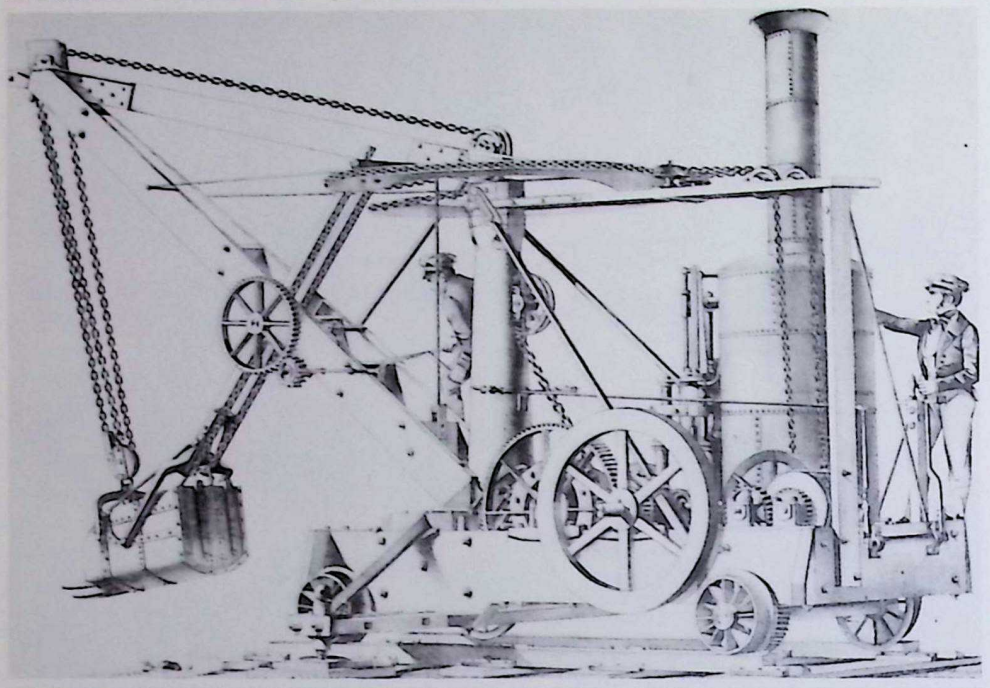
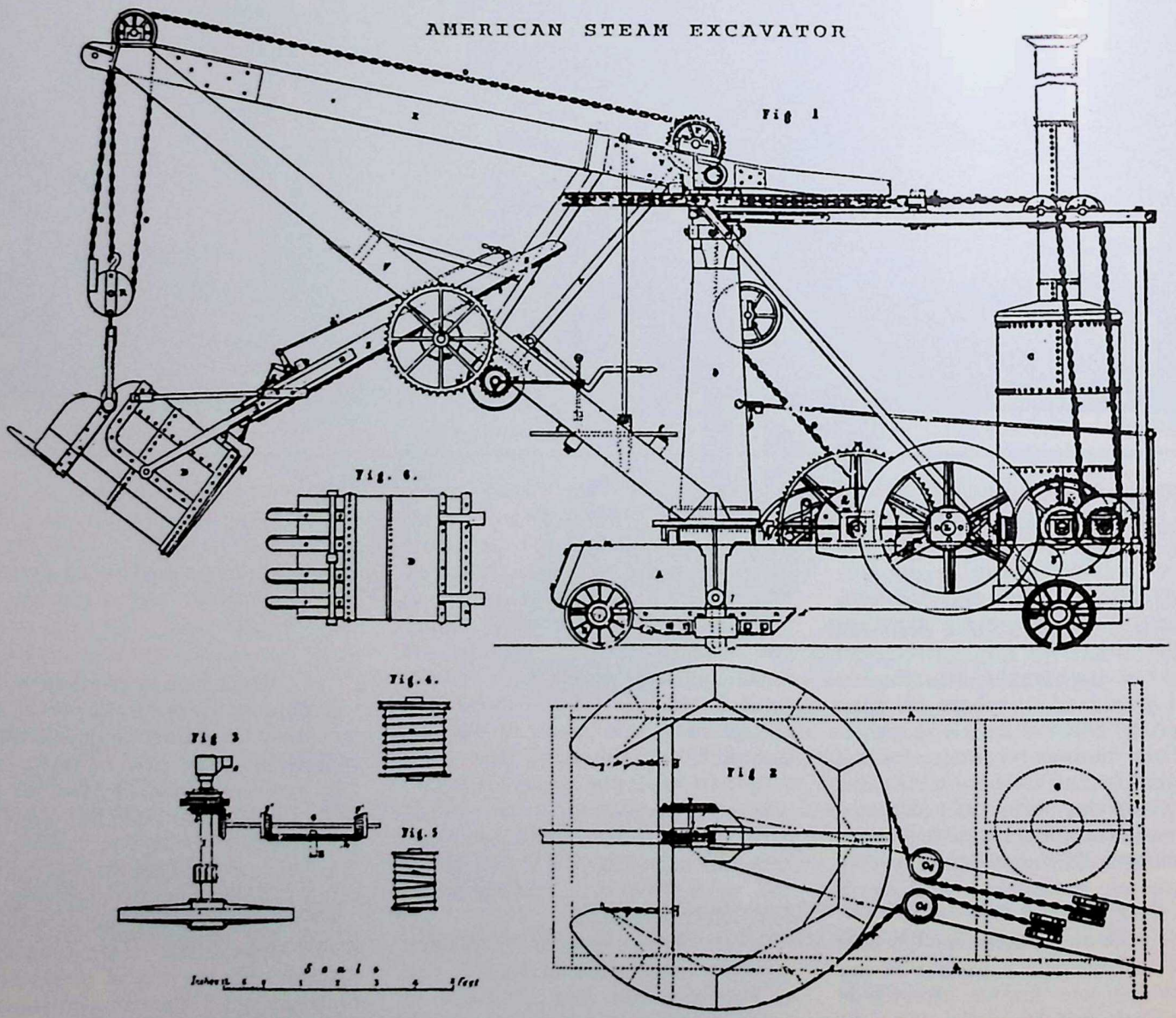


Fig. 3 *A reproduction of the Mason drawing which appeared in the London Journal in 1843. The drawings are identical except that the English version features the addition of two operators.*

Fig. 4 *Mason's drawing of the Otis shovel, and early English copies, were in perspective. Fortunately, however, an English journal, desiring in 1843 to print an article on the shovel, commissioned a [illegible] George Spencer to make a scale drawing. From this drawing it appears that the 1-1/2 yard dipper had dimensions very similar to modern dippers of the same capacity.*



Otis shovel, had a scale drawing made to accompany their editorial. This drawing **(Fig. 4)** the article says, "was made by Mr. George Spencer from the original working drawings in his possession." The dipper of the shovel was frequently referred to as being of 1-1/2 cubic yards capacity and from the scale given on this drawing it measured 3'2" x 4'0" front to back, dimensions which compare very favorably with modern dippers of similar capacity.

Controversial Caption

A photograph of Mason's drawing was presented to the Baltimore and Ohio Railroad some years ago. The donor, or someone, wrote as follows on the photograph: "This shovel was first put to work on a section of the Baltimore and Ohio railroad in Maryland, then later taken to Canada and used on the Welland Canal. After that it was put on a scow and used as a dredge on the Sioux, it was finally wrecked in 1905 or 1906." **[See Appendix II, III]**

It is this information which has so often been quoted and has proven impossible to confirm. Unfortunately the author of these statements and the source of the information are unknown. Further information concerning this will appear in later pages.

If the Baltimore and Ohio Railroad was actually the first user of a shovel, it seems that it would have drawn attention to that fact at the time of its centennial. True, its records were lost in the Baltimore fire, but so far not even slightly confirmatory evidence of such "first use" by it is adduceable; and, further, there is no information indicating that it had any construction work of consequence under way during 1836 or 1837.

The first incontrovertable use of the steam shovel was on the Western Railroad of Massachusetts (now the Boston and Albany). The contracting firm of Carmichael, Fairbanks and Otis were in 1838 at work in Springfield, Massachusetts, finishing the link connecting Springfield and Worcester.

"B & O" or "B & A"?

In writing of the B & O and B & A, the appearances of the "A" and "O" may become confused and in speaking, the sounds of the respective initials of the roads are quite similar, if at all slurred.

Trains began to run over this section October 1, 1839, according to a notice by George W. Whistler, Engineer. **[See Page 13]** Bids were received April 15, 1839 for the adjoining section extending from the Connecticut River west to Chester, and these same contractors were among the successful bidders. It was while building this road through Westfield, Massachusetts, that Otis died on November 13, 1839, at the age of 26. Some accounts attribute his death to typhus and others to an accident while operating the shovel, although there is no confirmation of the latter belief. **[See Appendix I]**

After the completion of this contract the shovel was used on section No. 3 of the Schenectady and Troy railroad. The following quotation from the Troy Daily Whig is given in full because it is so graphic and is the first complete record of the shovel's manner of operation:—

"STEAM EXCAVATING MACHINE":

"The steam excavator, which has been at work for several months past upon the line of the Schenectady and Troy Railroad continues to excite a lively interest among our citizens, thousands of whom have been prompted by curiosity to pay it a visit. The triumphant success attending its execution in a material hitherto untried, and in which the skeptical had predicted it would be impossible to use it, has surpassed the most sanguine anticipations of its friends, and inspired the public with fresh confidence in its merits.

"It is most emphatically a labor saving engine—a novel and ingenious arrangement of the mechanical powers—another application of the one great revolutionizing agent, steam, to the useful purposes of life. It is an original idea and a universal good. It is one of those rare inventions, where genius seems to have marked out for itself an independent field of action, and the benefits flowing from which are destined to be known and felt throughout the civilized world.

"The utility of the machine is no longer a matter of speculation. In clay, sand and gravel, the materials most usually encountered in excavations of great magnitude, it has enjoyed the full tide of successful experiment, and its advantages, not only in the saving of labor, expense and trouble, but in the expediting of work are established beyond the possibility of doubt.

"The steam excavator was brought into use about four years since on the Western Railroad in Massachusetts. It was invented by William S. Otis, since deceased, a man of extraordinary mechanical genius, and a member of the well-known firm of Carmichael, Fairbanks and Company, railroad contractors. A patent right,

(Continued on Page 8)

The Republican

SPRINGFIELD
Saturday, May 19, 1838.

Western Rail Road.—Under the direction of the efficient Agent and Engineer, this work is going forward with spirit. Contracts were taken out the past week, for 32 miles of the Western R. Road, extending from Middlefield (through Pittsfield) to the west line of the State. A large number of responsible contractors were in town, and about 900 bids were offered, on the different sections. A part of this route is over the mountain, and is of course the most difficult to grade; but the work is to be done with all possible despatch. The other part of the road, from Middlefield or Chester, to the Connecticut River, will be contracted for in season for completion as soon as the mountainous part is done. From the river, east, it is expected the Road will be completed and in operation in about a year; and the section from Pittsfield to the New York line, in the same time. The intermediate part will take from six months to a year longer. Abundance of laborers are procured, we understand, at 85 cents a day, the board being deducted from that sum.

Upon the road in the eastern part of this town, is a specimen of what the Irishmen call "digging by *stame*." For cutting through a sand hill, this steam digging machine must make a great saving of labor. A strong sheet iron scoop, holding about half a cart load, swings in a crane by chains and is made, by the operation of the engine to strike into the hill and fill itself by the winding of the chain. It then swings round over the cart, when the bottom, being fixed like a trap door, by the touch of a spring, drops open and lets all the sand fall into the cart. The machine will thus fill two carts as fast as they can be drawn off and emptied. Each cart-load is drawn by one horse on the temporary railway, to the neighboring valley to raise it to the proper level. Thus the hills are laid low, and the vallies made high. ■

Joseph Harrison Jr.

JOSEPH HARRISON was apprenticed at the early age of 15 to Frederick D. Saws to learn the machinist trade, but after about two years Saws failed, and Harrison signed apprentice papers with James Flint, with whom he remained until he was 22 years old. After serving as machinist for a short term, he made a gesture to operate a shop of his own at Port Carbon, Pa., but soon accepted a foremanship with William Norris, then a well-known manufacturer of locomotives.

Garret and Eastwick were not as well known locomotive builders as either Norris or Baldwin and, appreciating the need of improving their prestige and product, they persuaded young Harrison, now 25, to accept the foremanship of their shop. In two years he became a junior partner and in 1839 he bought out Garret and thereafter the firm was known as Eastwick and Harrison. Therefore, really the first shovel built in Philadelphia was built by Garret and Eastwick not Eastwick and Harrison.

During this period Harrison became famous by designing what was called the "Gowan and Marx" locomotive. This locomotive weighed 11 tons and attracted worldwide attention on account of its performance.

Because of the fact that the engines being built by the firm of Eastwick and Harrison contained certain valuable features patented by either Mr. Eastwick or Mr. Harrison, representatives of the Russian Government selected their company to build locomotives for the railroad contemplated between St. Petersburg and Moscow.

On the invitation of the Russian Government, Mr. Harrison left in the spring of 1843 for St. Petersburg and concluded a contract at the end of that year for the building of 162 locomotives and iron trucks for 2500 freight cars. Mr. Eastwick joined him in the latter part of 1844, after closing their shop in Philadelphia and removing most of the "tools and instruments" to St. Petersburg.

According to one account, a factory 375 feet long by 60 feet wide was built for the purpose of constructing equipment for the railroad.

This plant was known as the Alexandrofsky Mechanical Works. Some description of the methods of handling labor may be found in the following quotation:

"To keep order among such a congregation—exceeding the whole population of a good-sized town, and consisting of English, Americans, Scotch, Irish, Germans, and Russians—a company of soldiers is kept on duty at the works, and a perfect police force, whose duties are confined to the establishment. Refractory men of every nation are discharged for irregular conduct, excepting Russian, and these (we suppose it is to inspire them with a love for their country and admiration for the gentle Nicholas) are, for the slightest offense, immediately tied up to the triangles, soundly flogged, and sent again to their work. It is but justice to Messrs. Eastwick and Harrison to say that they have strongly appealed against this treatment, so peculiar to this semi-barbarous nation, but without effect. The plan of paying this enormous multitude is ingenious; on being engaged, the man's name is, we believe, not even asked, but he is presented with a medal, numbered: in the payhouse are 3500 wooden boxes, and, on presenting himself on Saturday night for his pay, the clerk hands him his money, takes his medal as a receipt, which is dropped into the box of its number, and gives him another medal, as a pledge of engagement for the following week."

It was reported that the factory was able to turn out six cars and passenger carriages all finished per day, and three locomotives per week.

Incidentally, this same article also adds "and the employment of the railway excavator has served greatly to accelerate progress." [See Appendix 1]

In 1852, Harrison returned to Philadelphia to lead a life of retirement and ease. He is reputed to have been the first resident of that city to own a private art gallery. In his boyhood days he had frequently been told the story of the Blacksmith and King Solomon, so he had an artist paint a picture portraying this story for his gallery and anyone interested will find the picture, the story, and more about Harrison in "The Ironworker and King Solomon" — a story he wrote for his children and grandchildren, printed in 1869.

After a few years, he began to tire of idleness and built a plant to manufacture a patent boiler known as the Harrison boiler. He died at Philadelphia on March 27, 1874. ■

embracing the most recent improvements, has been secured and the proprietors are now making arrangements for its use upon a scale in some degree commensurate with the magnitude and merits of the invention.

Eight to Sixteen Horsepower

"The machines hitherto constructed, varying in power from eight to sixteen horses, have cost from five to seven thousand dollars. The one in use upon the Schenectady and Troy road is of the medium size, and is at work in fine compact marley clay of both the blue and light colored varieties. It is estimated to do the work of fifty and sixty men. Only two men are employed in the operation—the engineer and conductor, the man at the shovel, wood and water being provided by other attendants.

"It is easy to conceive how varied must be the duties of a machine calculated to perform at once the offices of the pick-axe, the shovel and the man. A great variety of motions are required in breaking up the material, filling the shovel and depositing its burden in the vehicles which are to remove it from the excavation. All these the machine accomplishes with a most perfect regularity and precision. The trunk of the tamed elephant, as he quietly addresses himself to his master's bidding, is no inapt emblem of the grace, majesty and strength of its movements.

"At first glance the machinery of the excavator, from the novelty of its appearance, strikes one with the idea that it is extremely complicated in its structure, and hence, liable to be often deranged and thrown out of repair, and, withall, expensive of maintenance. But this illusion is soon dispelled.

"A more careful examination convinces us that simplicity is a chief attribute, and the first impression is followed by a sentiment of profound admiration at the display of mechanical ingenuity which has been exhibited in making so simple a combination of wheels, levers and chains, to perform so many and such varied operations.

General Construction Description

"It would obviously be impossible to trace the arrangements of the machinery through all their detail, without reference to drawings and models. We shall attempt however to give

some general idea of its construction, and at the same time follow out the principles upon which its action depends. In the first place, then, the steam engine, boiler and connecting machinery, are situated in a strong carriage, resting upon a temporary railway track laid for that purpose. The shovel, which has a capacity of one and a quarter cubic yards, is suspended by a chain tackle of the ordinary construction, at the extremity of a sort of crane or boom projecting from the top of a mast about twelve feet high, which stands on the front part of the carriage, and over which the power acting through the tackle is communicated.

"The shovel consists of a square iron box with a handle of strong wood attached to the side in such a way as to give it the form and appearance of a ladle. It is armed in front with heavy wedge shaped teeth about eight inches long, which serve to break the material in advance of the shovel, and also to remove any obstacle which might come in contact with its edge. To follow the machine through a single round of its functions; the shovel is first brought to the bottom of the pit, in a position nearly horizontal, with the handle projecting upward and passing through the brace work of the crane by which means a steady action is at all times secured.

"The chain tackle, acting from the end of the boom, and attached to the shovel by a ball and pivots, and deriving its power from the grooved windlass on the carriage around which the chain winds, then commences to draw the shovel forwards and upwards, while another chain made fast at the end of the handle and winding in the same manner on a drum situated in the brace work of the crane near where the handle passes, serves to press the shovel against the face of excavation in its upward passage, and thereby to regulate the depth to which it penetrates.

"This latter chain is so adjusted, by means of a friction wheel and levers, as to exert just so much power at any instant as the operator may choose to apply. The friction wheel above protects the shovel and other machinery from any unforeseen danger; for as all the power which acts to apply the shovel is transmitted through this wheel, and the friction is regulated to correspond with the strain which may safely be encountered, it is evident that whenever the shovel is suddenly arrested by a large rock or other impediment, the shock will not be felt back of the point where this wheel is situated and other parts including the upward motion of the machinery of the shovel, may continue to move on as though nothing has happened.

"The shovel is generally filled by the time it has risen ten feet, when the chain tackle ceases to act, and the shovel remains suspended by it from the end of the boom, with its centre of gravity slightly in advance of the point of suspension. The chain connected with its handle now relaxes and the shovel retreats, by its own gravity, two or three feet from the face of excavation, and the crane swings round till the shovel comes directly over the cars standing at the side of the machine. The load is discharged through a movable bottom, turning upon hinges and secured by a catch, the connecting rod of which terminates upon the stand of the conductor.

"The crane now swings back to any position within a half circle where it may be desirable to take up the next load, while, at the same time, the shovel falls to the ground, the movable bottom clasps itself, and all is ready to proceed as before. The alternate swinging motion of the crane is produced by a chain coming from a driving pulley situated near the engine. The middle portion of this chain being occupied by the driving pulley, the two parts lead upward to the roof of the carriage, from which their direction being changed over small pulleys, they pass around to opposite extremities on the rim of a horizontal semi-circular frame, made fast to the boom and projecting from what may be termed the rear side of the mast.

Moving Up

"When all the material within reach of the shovel has been removed, rails are laid down and the machine advances by its own locomotive power to a new station. This motion is accomplished by simply gearing the main shaft of the engine to a cog wheel on one of the axles. The distance moved is usually about three feet, and the time occupied in changing places does not exceed three minutes.

"The average time consumed by each revolution of the shovel is forty-five seconds and the quantity taken up in broken clay varies from one-half to three-fourths of a yard, solid measure. Taking the result of one hour at forty yards, which is making a liberal allowance for contingencies of all kinds, and reckoning eleven hours per

Charles Howe French

CHARLES HOWE FRENCH was born at Canton, Massachusetts, in 1814. He was left an orphan at a very early age and when only sixteen was apprenticed to a millwright. There is little doubt that Otis made the acquaintance of French as certainly became intimately acquainted with him, because they were frequent visitors at the home of Edward Everett in Canton, and shortly after Otis' marriage to Elizabeth Everett, French married her sister Almira.

French continued his association with the firm of Carmichael, Fairbanks and Otis until it was broken up by the death of Otis and the departure of Fairbanks for Russia. Later it was reported that Carmichael took French into partnership with him when he secured a contract for widening a portion of the Welland Canal and that although Carmichael returned to the States within a year, French continued for five years in Canada until the work was completed. Authority for the statement has not been found, but it is reported that on this contract French used an Otis shovel . This was probable the work done in the year 1850 between Welland and Port Colborne although as early as 1841 the legislature of upper Canada decided to enlarge the canal. As this work was in the nature of dredging and as the two shovels built in Philadelphia were probably in continuous operation in the States, it is probably if an Otis shovel was used on the Welland Canal it was the original shovel built in Canton.

French returned to Canton after completing the work in Canada and engaged in a number of industrial adventures, in one of which he was a partner of O. S. Chapman. [See Appendix II] ■

day, and twenty-four working days per month, we have 11,500 yards for the average monthly performance of the machine in clay excavation. In sand and fine gravel, upon other public works, it has repeatedly accomplished 18,000 yards in the same time.

Advice to Citizens

"The excavator used upon the Schenectady and Troy railroad is now at work near the "deep cut' on Section No. 3, one and a half miles west of the city. It will be employed here till June or July next, at which time the whole road will have been completed—this being the heaviest section on the line. Meanwhile we trust that all who have a taste for novelty, or feel interested in the progress of mechanical improvement, will embrace an opportunity of witnessing its performances and satisfy themselves of the benefits, which are to result from its use in the construction of railroads and other improvements.

"But its advantages are not to be enjoyed by public works alone. There is no doubt but it may be applied successfully to the ditching of large tracts of level country such as are everywhere to be met within the southern states. Wherever channels are required of sufficient size to allow of its being applied in the usual manner, (say six feet deep by ten feet in width), its operation would be attended with most decided economy; and, in drains of lesser dimensions, it might be used with nearly equal success by slightly varying the motion of the shovel so as to allow the carriage to stand upon the surface of the ground.

TROY DAILY WHIG."

The Schenectady and Troy Railroad was some twenty miles in length and was put in operation in September 1842.

Later Excavating Reports

The shovel, in fact two shovels, are next reported as in operation in Brooklyn, N.Y. The Daily Tribune of New York City in an article headed "Steam Paddy" which it published in February, 1842 said:

"In the vicinity of the Navy Yard are two steam excavators now at work in levelling holes and filling lots. At one operation they each take up a cubic yard of sand which is loaded in a railroad car and sixty cars loaded in an hour, which passes from the hole on tracks laid on an incline plane. The machines cost $4500.00 each. Notwithstanding such facilities, it is said that laborers with their horses and carts can do the work about as cheaply."

Opinions Differ

Shortly thereafter another author wrote:

"Two of these machines are now employed at Fort Green, Brooklyn, in excavating the hill and filling a deep hollow on the border of the former salt marsh. We have several times paid a visit to this truly wonderful machine, and gazed with astonishment upon its untiring labors. Many steam excavators have been invented, but as far as we can ascertain, this is the first that has been brought into successful operation."

The committee of managers of the fourteenth annual fair of the American Institute of the City of New York were especially commissioned to examine and report upon the steam excavators at work in Brooklyn. Their report reads:

Daniel Carmichael

THERE is little record of the early life of Daniel Carmichael other than the fact that when Otis was a very young boy and his family were living at Otisville, New York, the Carmichael family lived only a few miles away at Mamkating. In 1820 Daniel Carmichael married Almira Otis, an aunt of Wm. S. Otis. She died in 1831, and Carmichael married her niece, Eliza Otis, in 1832. He was the senior member of the firm of Carmichael and Fairbanks, which later became Carmichael, Fairbanks and Otis. This firm was evidently one with a reputation for good and efficient work.

From 1835 to 1846 the record of Carmichael is clearly traced through the use of the steam shovel. After the completion, however, of the Atlantic Docks in Brooklyn in 1846, when Carmichael's partner was James Stranahan, no information seems available. It is known that he had a son, Henry Carmichael, who graduated at Amherst, studied abroad and later became a distinguished consulting and manufacturing chemist, who last lived at Malden, Massachusetts, where he died in 1924. ■

"Accompanied by Professor Griscom, Senators Hunt and Works, General Tallmadge, President of the Institute, and General Chandler, Vice-President, with various other scientific gentlemen, your committee proceeded to Brooklyn and examined the machine in successful operation, cutting down a hill to fill up and form a park in the swamp land near the navy yard. It appears that the original machine was invented some three or four years since Mr. William S. Otis and has been improved upon since by the present owners, Messrs. Carmichael, Fairbanks & Otis, and the general agency thereof belonging to Mr. John W. Coch[illegible]

"The excav[illegible] would seem to be no new unt[illegible]onception, but has been employ[illegible]ring the last three years upon t[illegible]estern Railroad and other places, [illegible] that this test has shown an imm[illegible] saving of expense.

"It works well in clay, sand, gravel and all soils; being placed upon a car it changes its position easily, and advances or recedes in the manner of a locomotive, as the case may require.

"Your committee found the machine at work, and not set up for exhibition.

"The great value and importance of this invention to our country in digging canals, levelling ground for railroads, and the practicability of its application of clearing docks, slips and mouths of rivers, render it of the very first consequence.

"The masses of unruly men collected on our public works will be dispersed by its use, and compelled to till the land, thereby making them good and quiet citizens, and putting an end to the disturbances, quarreling and complaints incident to such collections of men.

"The inventor having died, leaving a widow and family, your committee respectfully recommend the highest premium of the Institute to be given to the widow, with a suitable letter, and a proper diploma to Messrs. Carmichael, Fairbanks & Co. and to Mr. Cochran, to show them the value the American Institute sets upon their services to the country, in perfecting and bringing the machine into practical operation.

"All of which is respectfully submitted.

GEO. C. DE KAY
MARTIN E. THOMPSON
JOSHUA B. HYDE
ALFRED STILLMAN
Committee."

The work in Brooklyn, the first on record where two shovels were used on one job, was the excavation for the City Park. Considerable progress had been made by January 1842, for Mr. Fairbanks, one of the firm, was asking counsel for a partial payment of $5,000 on account. This request was referred to the finance committee.

Other Projects

In 1840 the Atlantic Basin project was incorporated. It was begun in 1841, encountered difficulties in 1843 and was not completed until 1846.

Carmichael and Stranahan, contractors, did a large part of the work. Carmichael, who owned the two shovels, lived from 1843 to 1846 on Butler Street near the Atlantic Basin. It is therefore [illegible] assume that these two shovels were also used there, probably until completion of the Brooklyn [illegible].

The fate of these two shovels is more or less shrouded in mystery. With Otis dead and Fairbanks probably gone to Russia, only a biography of Daniel Carmichael, the other partner, could clear this up.

It is rumored, but not confirmed, that a shovel or shovels were used in the construction of the Erie Railroad, possibly near Port Jervis, Pennsylvania. In any event, Carmichael and Stranahan are listed as contractors for a portion of the Erie Railroad. **[See Appendix I]**

Isaac Otis, a brother of the inventor, wrote as follows in 1872:

"Dillon, Chapman & Clyde used steam excavators on the Lake Shore Railroad near Girard, Pennsylvania, where they had a contract to move 1,000,000 cubic yards of earth."

The work referred to in this letter was done about 1852-1854.

There is every reason to believe that men like Sydney Dillon, O. S. Chapman, C. H. French, T. C. Durant, and others, who at one time were associates or employees of Carmichael, afterward used these shovels on various contracts.

Canton Shovel on the Welland Canal?

There is every evidence that shovels were used on the Welland Canal. There were four periods of its construction, the first occurring too early for power shovels to have been used.

The second period was about 1840 to 1850, and it is known that Carmichael and French had a contract at this time somewhere between

Fig. 5 Phil Rouse was born in Thorald, Ontario. When the Otis shovel was brought in to work on the Welland Canal, he was so fascinated by it that he went to work as a water boy, at the age of 10 or 11, in order to be near it.

Welland and Port Colborne, but as Carmichael then was using the only two shovels built in Philadelphia, still on this side of the Atlantic, upon the construction of the Atlantic Docks, if a shovel was used on the canal, it must have been the one built at Canton, Massachusetts. The following quotation from a letter substantiates the report that a shovel was used on the canal at this time.

"Hosea T. Stock made the designs for a dredge in which was put the machinery of an Otis Steam Excavator owned by Charles H. French. The dredge was built at Allanbury, Ontario, 1843 is the date that sticks in my head (H. T. D.) the dredge laid idle for one year on account of threats from the Irish laborers whose mouths it would rob.

"After they were starved out and went away, the dredge started. When they came to run the canal at Port Colborne through a swamp, the exhausting pumps of the dredge were inadequate to keep the cut dry and so the dredge had to stop, so I have been told by Father and Grandfather. Both told me they would write me what they knew of the first start but they never did it." **[See Appendix I, II]**

During the third period of construction of the Welland Canal about 1870, several Osgood and Otis-Chapman dipper type dredges were used.

Also, there is first hand testimony that an original Otis shovel was used on the canal at this period. Phil Rouse, for many years an erector for Bucyrus-Erie Company, remembers working as water boy on this shovel. He tells the story of its use on the canal. **(Fig. 5)**

"John Brown was contractor on several sections of the third step in construction of the Welland Canal, near Thorald, Ontario. He had four dredges working there, and brought this Otis shovel in from the states. It was the first steam land excavator ever used in that part of the country and was used to cut slope. The crew consisted of an operator, a craneman, a fireman, and about two men in the pit. The operator had the hardest job, working right next to the boiler where it was always hot. I carried water—two pails hanging on a yoke across my neck. I used to stop on my trips for water and watch the shovel work till the water got warm. Then my crew would get mad, dump the water out and I'd have to go get more. But even the cussing and extra work couldn't cure the intense fascination this new machine held for me. That shovel turned out good yardage at a considerable saving compared with hand labor and built a good grade, too. They worked it on wood rails. When they wanted to move, they'd lay a new section, then hitch a couple of horses to the shovel to help pull it along.

"They dumped into homemade, timber wagons that held two dippers and had three wagon-type wheels, two big ones with flat iron tires, and a smaller one in front. These carts were pulled by one horse and dumped by hand. An extra horse was sometimes used as a "helper" on the grades. The horse pulled the carts over to the slope, a rope was hitched on, and they were pulled up the slope on a plank runway. From the top other horses pulled 'em over the dump.

"Some of these wagons were fixed so they could dump either over the side or end. The body was revolving, so if they wanted to lengthen the fill, they'd just whirl the car around and "end-dump" it.

"Charley Coleman was the first operator on this shovel, and he broke in the second, "Dad" Wilson, his nephew. Jim Canan was superintendent.

"When section 15 was cleaned up, the shovel was loaded on a barge and moved to the "deep cut" between Allenberg and Port Robinson. Then later, it was brought back to Thorald and put to digging rock on section 16.

Everybody thought John Brown was crazy—trying to dig rock with a steam shovel, as this was the first time, according to our organization, that one of these new "contraptions" had been used for heavy digging.

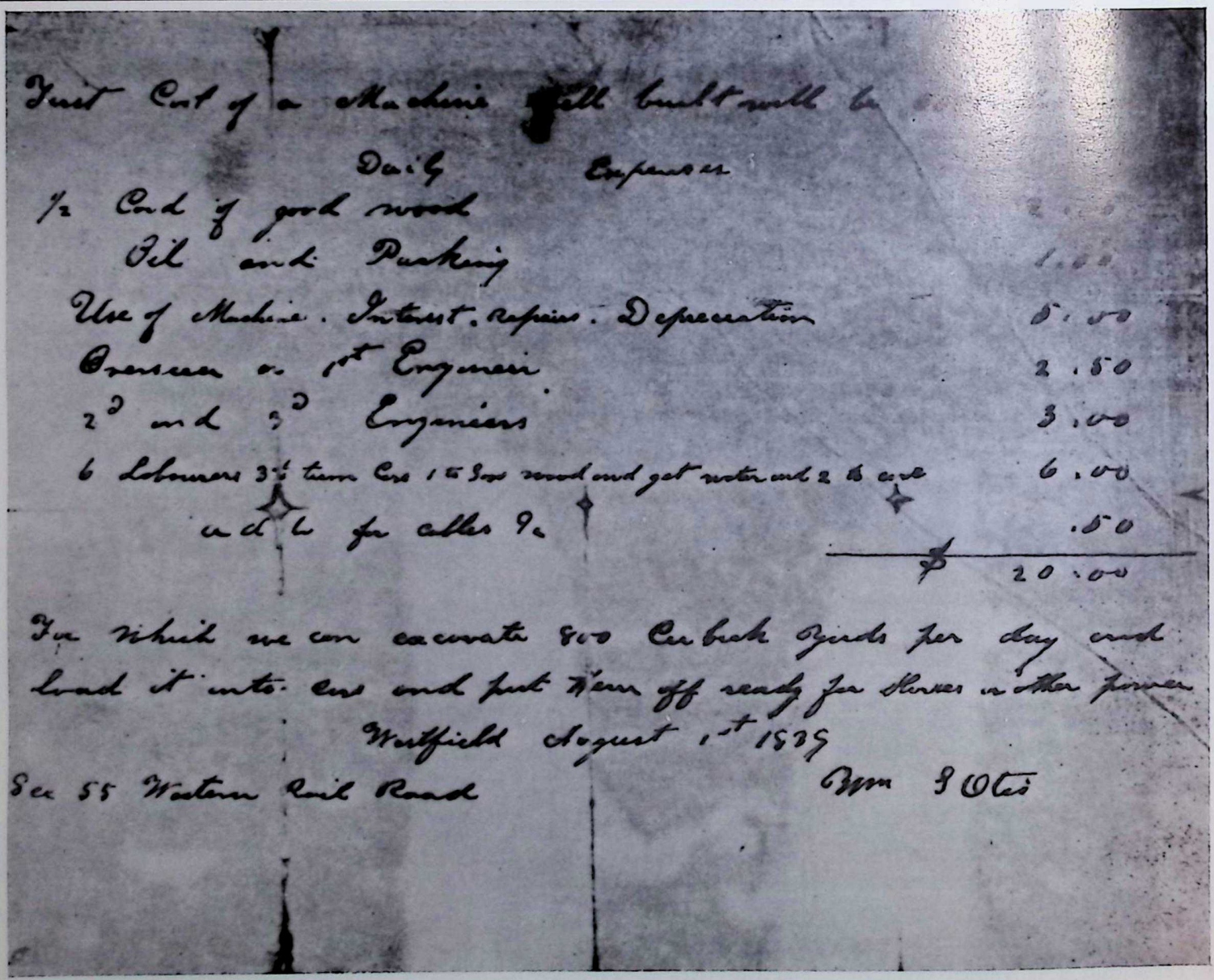
"About 10 or 12 feet of overburden had been stripped off by hand, leaving solid rock about 10 feet thick. They had one little steam drill, and blasted with black powder. I was only about 11, and I don't remember how they set off the charge. The shovel tied into the blasted rock and made excellent progress without any serious delays for repairs.

"John Brown grinned all over every day when he came along on his inspection trip and watched the Otis piling the rock into the cars. When the work was completed, the shovel was sold to a contractor who dismantled it, put it on a sailing vessel and shipped it up to a Lake Superior port where he could move it overland to his contract on the Canadian Pacific. "Dad" Wilson went with the shovel, set it up and operated it for about a year. And that's the last I heard of it.

"Most of the pick-and-shovel men working on the Welland Canal were Swedish or Italian. Wages were ten cents an hour, for ten hours a day, six days a week. As a water boy I got fifty cents a day. The shovel operator got eighty-five or ninety dollars a month, and that was considered fine pay. Shacks were built along the canal for the laborers to live in, and they boarded themselves."

What About the Sioux River?

Statements that an original Otis shovel was used on the Sioux River may also come from such a confusion of names as occurred with the B.&O. and the B.&A. Railroads, for Sioux sounds much like salte. While no work of that period has been traced to the Sioux, dredging was done on the Saulte Ste. Marie in 1854 and the description says that a dredge built by Osgood and based on the Carmichael-Osgood patents of 1846 (referred to later) was used. This was essentially an Otis shovel mounted on a dredge, and the confusion through calling it an Otis shovel could easily occur. Incidentally, while there is a Big Sioux River and a Little Sioux River, there is no Sioux River. ■


Just Cost of a Machine will built will be

Daily Expenses

1/2 Cord of good work

Oil and Packing 1.00

Use of Machine. Interest. Repairs. Depreciation 5.00

Oversees or 1st Engineer 2.50

2d and 3d Engineers 3.00

6 Laborers 3/4 time Cos 1 to 3 to wood and get water and 2 to cut 6.00

and 6 for cullers 9c .50

$ 20.00

For which we can excavate 800 Cubic Yards per day and load it into cars and put them off ready for shovel in other form

Mattfield August 1st 1839

Wm S Otis

Sec 55 Western Rail Road

Fig. 6 According to this expense account in Otis' handwriting, his shovel loaded for a little less than 2-1/2 cents per cubic yard on this job.

After the death of Wm. S. Otis and the completion of the seven Philadelphia shovels, about twenty years elapsed before any more power shovels were built. It is possible, however, to trace the activities of the existing machines in this country and abroad.

Russia Imports U.S. Machines and Engineers even in 1842

Russia was the largest customer for the original Otis shovel. Four shovels were shipped to Russia and one to England, and two only remained in the United States. This statement refers only to the perfected shovels built in Philadelphia and does not include the first or experimental one built at Canton, Massachusetts.

It is not pertinent to the history of the shovel to discuss in detail the part played by the engineers and artisans of the United States in building the railroad from St. Petersburg to Moscow. A certain Chevalier de Gerstner was sent to the United States in 1839 to investigate our methods of railroad construction. He reported that one of the causes of cheap construction here was the "use of labor saving machinery, particularly the steam excavating machine used in constructing the railroad between Worcester and Springfield." On Gerstner's recommendation, Major George W. Whistler, who was then chief engineer of mthe Western Railroad where the shovels were being used, was selected as consulting engineer for the Russian road.

The following is an account by a visitor to the plant of Eastwick and Harrison in Philadelphia in September 1843:

"The Otis excavators are to be used extensively on the St. Petersburg and Moscow Railway in Russia. One machine was sent out last year (1842) and three more have just been completed and are now ready for shipment. Messrs. Fairbanks and Carmichael, the owners of the equipment, have, we understand, taken a contract for the excavation of 25,000,000 cubic yards on this road."

Many other orders for machinery and machine tools for Russia were placed in Philadelphia at that time, to such an extent that one authority said: "but for the Russian orders many of our industrious mechanics would now be out of work."

Further details of Russian activity are given in the biographical sketches of Gerstner, Whistler and Harrison.

France Gets a Glimpse of an Otis

The first of the four Otis shovels sent to Russia was shipped in 1842. This shovel was unloaded when the ship reached France and a demonstration given in Paris as the following statement, taken from a Paris journal of 1843 shows:

"A trial of an immense machine for cutting railroads named by the inventor, a native of the United States, "The Railway Excavator," was made yesterday in the premises of Messrs. Varvole and company, the engine and engine makers in the Avenue Trudaine. A large heap of earth and stone was placed at one extremity of the yard and the machine having been set to work by means of an engine of 20 h.p. forming part of it, the greater part was cut through and the rubbish thrown aside in a few minutes. One of these machines is, we understand, now in use in the Eastern Counties Railroad."

No record has been found as to the negotiations which led up to the shipment to England of one of the Otis Shovels built in Philadelphia. It is a matter of record, however, that

(Continued on Page 14)

George Washington Whistler

MAJOR WHISTLER was born May 19, 1800, and was graduated from West Point Military Academy in 1819. There was no school or college except West Point that was then able to provide an engineering education; and because engineers were absolutely necessary for the preliminary survey in determining the route of a railroad, the War Department recognizing the value of railroads to the government, adopted the practice of lending or assigning army engineers for this purpose.

Major Whistler's first assignment was as assistant under Major Wm. Gibbs McNeill in the years 1828 and 1829 in connection with surveys for the B. & O. Railroad. He was, from 1837 to 1840, consulting engineer and, in 1840 to 1842 chief engineer, on the Western Railroad of Massachusetts. It was while he was acting as consulting engineer for this road that he made the acquaintance of Chevalier de Gerstner.

Major Whistler was engaged to become consulting engineer for the St. Petersburg and Moscow Railroad, for which position he left the United States early in the Spring of 1842.

He had had a practical demonstration of the real value of the steam shovel while the Western Railroad was under construction. It was, therefore, perfectly natural that he should contemplate using these machines in Russia.

The records conflict as to whether four shovels were purchased by Russia or whether, as reported, a contract for excavation on the Russian Railroad, amounting to some 2,500,000 cubic yards, was awarded to the firm of Carmichael and Fairbanks. In any event, four Otis shovels were shipped to Russia.

The records state that "Whistler was forced to organize and plan everything 'from a wheelbarrow to a steam excavator.' " He not only acted as consulting engineer for the railroad but, as time went on and his full value was appreciated, he was consulted on all military engineering and river and harbor improvements. He was given the Cross of the Order of St. Ann. While the corruption prevalent in high places attacked him, his integrity withstood every trial and temptation. In 1848 Whistler contracted cholera but recovered. On April 7th, 1849, he passed away during a heart attack and was succeeded by Major Thompson S. Brown.

His body was brought to the United States and is buried in Greenwood Cemetery under a cenotaph designed by Julius W. Adams and erected by his fellow engineers. Major Whistler left a son no less distinguished in the field of portraiture than his father was an engineer, the portrait of his mother being universally familiar. ■

a John Duncan, reported to have been engaged for some time as a solicitor to various railway companies, was responsible for the introduction of the machine into England, and that the construction and licensing of further machines for England and the Continent were entrusted to a John Braithwaite. This was the result of letters of endorsement of the shovel received from Major Whistler, Captain Swift and Major MacNeill, all prominent chief or consulting engineers of American Railways.

There is also some doubt as to which of the seven shovels went to England. The date of its arrival there is also not recorded but it was in use as early as 1842.

The English shovel was put to work on the Eastern Counties Railway, as the following quotation from an article printed early in the year 1843 shows:

"Rumor had informed us, that an American Excavator on railways worked by steam existed, which could perform the labor per day in getting and filling of 100 men, and could in all ordinary soils excavate 1,000 cubic yards per day. It was reported to us that such a machine had arrived in this country, and that it was to be seen at work upon a bank of stiff clay adjoining the Eastern Counties line near Brentwood; and we proceeded on Tuesday last to the spot. It is impossible in adequate terms to express our gratification at the visit.

"We sincerely desire that it may have every success, and also its twin brother, the Excavator under water, which we understand is, if possible, a still more efficient machine than the dry land excavator. The invention is one which reflects the greatest credit upon the mechanical skill of the United States, and of the inventor, Mr. Otis, who, unfortunately, does not live to be gratified with its success; and every man in England who desired to witness the triumph of machinery, will be well repaid by a journey down the Eastern Counties Railway to Brentwood, to visit it when at work. The public are indebted, we believe, for the introduction of the machine into this country to the enterprise of Mr. Duncan, in whose name the patent stands, and who has long been known to be engaged as a solicitor to various Railway Companies; and when we state that the construction and licensing of the further machines required for the public works of this country, and of the Continent, have been entrusted to John Braithwaite, this is a sufficient guarantee that they will be made effective to the fullest extent, and come into extensive operation."

This article elicited one comment of such interest that its inclusion in this article seems worthwhile.

What's All the Fuss About?

"Sir—

I see in the Railway Journals an account of an extraordinary excavating machine—a real 'Giant'—which has been imported from America and may be actually seen at work in the Brentwood cutting of the Eastern Counties Railway, doing such superhuman wonders that half of the race of 'navvies' may thenceforth consider their 'occupation gone.' 'The machine is made,' quoth one would-be emphatic writer: 'it can work admirably; it must come into use; and it is utterly futile to weep over the deprivation of employment to navigators.'

"Let us see. The machine, it is said, can 'perform the labor per day, in getting and filling, of 100 men, 'and the proof is that it lifts and fills' nearly a cubic yard and a half of stiff clay in about the same space of time as a laborer would lift and fill a foot cubic. 'But a cubic yard and a half is equal to 40-1/2 cubic feet only; so that testing the assertion by proof adduced, the pretented performance is at once reduced to 59-1/2—nearly one half; Now to say that it can do the work of 59-1/2 men is saying nothing; unless it could be also shown that it can cost less than as many men would. The engine is worked by steam power, but what the amount of that power is, the 'touters' of the 'Giant' have thought it prudent to conceal. Is it of 40, or 50, or 100 h.p.? From a cursory glance at it I would say somewhere about 40. Now that a 40 h.p. steam engine should do more than the work of 59-1/2 men, or even 100, or even twice 100, is anything but cause for exultation. If that is all it can do, the 'navvies' have nothing to fear. For, besides the cost of the steam power, some further inconsiderable deductions must be made for interest on the price of the machine, loss from tear and wear, and the wages of the two or three men required to work it.

"So much for the performances of the 'Giant,' a word now as to the mechanical scale shown in its construction. So huge, clumsy, and multudinous a combination of beams, shafts, posts, cylinders, pistons, levers, chains, wheels, pullies, etc. to accomplish a very small affair, I never before beheld. One cannot fancy a more instructive instance of the vanity of attempting to do by machinery what machinery is incapable of doing—for there might have been ingenuity in the attempt, and there is none; but I defy anyone to point me out an instance of more miserable failure. It is but a spade after all; a spade for a giant it may be—some 'briarcus with a hundred arms;' but still a spade only, that can earn for its giant owner no more than is necessary for decent maintenance.'

I am Sir
Your Constant Reader,
PROBE.

In thus expressing opposition to the steam shovel it should be remembered that "Probe" was really voicing the opposition of a tremendous army of pick and shovel men known in England by the name of "Navigators," called for short "navvies." **(Fig. 7)** These men were designated navvies because, previous to the construction of railroads, they were largely used in excavating canals.

As late as 1848 one author estimated that "for some years to come the work to be done in England would require over 200,000 men per day."

"Those Banditti..."

These men appeared to have been much given to drinking and striking. One authority speaks of them as "those banditti known in some parts of England by the name of navvies or navigators and in other parts as "bankers."

Since it is probable that this group of men in England was typical of those in other countries, the following description of them, taken from an English journal, should be of interest:

"The laborers who executed these formidable works were in many respects a remarkable class. The 'railway navvies,' as they were called, were men drawn by the attraction of good wages from all parts of the kingdom; and they were ready for any sort of hard work. Many of the laborers employed on the Liverpool line were Irish; others were from the Northumberland and Durham railways, where they had been accustomed to similar work; and some of the best came from the fen districts of

Lincoln and Cambridge, where they had been trained to execute works of excavation and embankment. These old practitioners formed a nucleus of skilled manipulation and aptitude, which rendered them of indispensable utility in the immense undertakings of the period. Their expertness in all sorts of earth work, in embanking, boring, and well-sinking—and practical knowledge of the nature of soils and rocks, the tenacity of clays, and the porosity of certain stratifications—were very great; and, rough looking though they were, many of them were as important in their own department as the contractor or the engineer.

Fig. 7 The Railway Navvy ready for action.

What the Well-Dressed Workmen Wore

"During the railway-making period the navvy wandered about from one public work to another—apparently belonging to no country and having no home. He usually wore a white felt hat with the brim turned up, a velveteen or jean square-tailed coat, a scarlet plush waistcoat with little black spots, and a bright colored kerchief round his herculean neck, when, as often happened, it was not left entirely bare. His corduroy breeches were retained in position by a leathern strap round the waist, and were tied and buttoned at the knee, displaying beneath a solid calf and foot encased in strong high-laced boots. Joining together in a 'butty gang," some ten or twelve of these men would take a contract to cut out and remove so much "dirt"—fixing their price according to the character of the "stuff," and the distance to which it has to be wheeled and tipped.

"The contract taken, every man put himself to his mettle; if any was found skulking, or not putting forth his full working power, he was ejected from the gang. Their powers of endurance were extraordinary. In times of emergency they would work for twelve or even sixteen hours, with only short intervals for meals. The quantity of fresh meat which they consumed was something enormous; but it was to their bones and muscles what coke is to the locomotive—the means of keeping up the steam. They displayed great pluck and seemed to disregard peril. Indeed the most dangerous sort of labour—such as working horse-barrow runs, in which accidents are of constant occurrence—has always been most in request amongst them, the danger seeming to be one of its chief recommendations.

"Working together, eating, drinking, and sleeping together, and daily exposed to the same influences, the railway laborers soon presented a distinct and well-defined character, strongly marking them from the population of the districts in which they laboured.

"Reckless alike of their lives as of their earnings, the navvies worked hard and lived hard. For their lodging, a hut or turf would content them; and, in the hours of leisure, the meanest public-house would serve for their parlor. Unburdened, as they usually were, by domestic ties, unsoftened by family affection, and without much moral training, the navvies came to be distinguished by savage manners, which contrasted strangely with those of the surrounding population. Yet, ignorant and violent though they might be, they were usually good-hearted fellows in the main—frank and open-handed with their comrades, and ready to share their last penny and those in distress. Their pay-nights were often a saturnalia of riot and disorder, dreaded by the inhabitants of the villages along the line of works.

"See the English, How they Work"

In illustration of the extraordinary working energy and powers of endurance of the English navvies, we may mention that when railway-making extended to France, the English contractors for the works took with them gangs of English navvies, with the usual plant, which included wheelbarrows. These the English navvy was accustomed to runout continuously, loaded with some three or four hundred-weight of stuff, piled so high that he could barely see, over the summit of the load, the gang-board along which he wheeled his barrow, whereas the French navvy was contented with half the weight. Indeed, the French navvies on one occasion struck work because of the size of the English barrows, and the strike was only quelled by the aid of the military. The consequence was that the big barrows were abandoned to the English workmen, who earned nearly double the wages of the Frenchmen.

The manner in which they stood to their work was matter of great surprise and wonderment to the French country people, who came crowding round them in their blouses, and after gazing admiringly at their expert handling of the pick and mattock, and the immense loads of "dirt" which they wheeled out, would exclaim to each other, "Mon Dieu, voila! Voila ces Anglais comme ils travaillent!"

Not as Complicated As It Looks

At a meeting of the Institution of Civil Engineers in 1845, J.B. Hyde described the Otis shovel and at the same time exhibited a model of a shovel or dredge in which he had incorporated certain improvements. Mr. Hyde said:

"At the first view, the machine appears complicated; but it is not so in reality. Still it is probable some of the arrangements may be simplified, as the machine has remained much as it was originally constructed for Messrs. Carmichael, Fairbanks, and Otis, eminent railroad contractors in the United States, who were driven to the invention of some method of rendering themselves independent of their workmen, who by constant striking, prevented the completion of the contracts undertaken by their employers.

"The trials of the Excavator on the Eastern Counties Railway were made under very disadvantageous circumstances; the workmen were inexperienced, the form of the shovel was not adapted to the nature of the material to be excavated, and so few wagons were provided, that frequent stop-

(Continued on Page 19)

NO DRAWING AVAILABLE

UNITED STATES PATENT OFFICE.

WILLIAM S. OTIS, OF PHILADELPHIA, PENNSYLVANIA.

CRANE-EXCAVATOR FOR EXCAVATING AND REMOVING EARTH.

Specification of Letters Patent No. 1,089, dated February 24, 1839.

To all whom it may concern:

Be it known that I, WILLIAM SMITH OTIS, civil engineer, of the city of Philadelphia, in the State of Pennsylvania, have invented certain improvements in the apparatus for and mode of excavating earth for the construction of railroads, canals, or other purposes where excavation may be necessary, which I effect by means of certain appendages to a scraper of the ordinary construction, which scraper is to be worked by a crane and is to take the earth immediately from the banks from which the excavations are to be made; and I do hereby declare that the following is a full and exact description thereof.

The drawing which accompanies this specification represents the crane, which I employ in excavating and with which I am at present operating, but I do not mean to confine myself to the exact construction and arrangement of this part, as it may be varied in its details, while the same effects may be produced by it. This crane is shown in Figure 1 as stationed upon a movable carriage, or car, and is situated on a temporary railway, and is intended to be so constructed that the load of earth taken off by the scraper may be raised by it, while the turning of the crane also to the point where the load is to be dumped, whether into cars or boxes on the road, or elsewhere, is controlled and regulated with great precision.

In the accompanying drawing, A, represents the scraper suspended from the crane, by means of the ordinary tackle; this tackle serving to raise it in the act of excavating, and to lower it when required. The end B, of this scraper is hinged to it, and has a bolt which keeps it in place when desired, or allows it to be opened and discharge its contents from that end. Such arrangements are well known to engineers and do not, therefore, require to be particularly described by me.

C, C, are two arms which are attached firmly to the scraper by means of the braces *a*, *a*, or in any other convenient mode. To these arms I connect an apparatus by means of which the scraper may be made to advance, or by which it may be drawn back at pleasure; which apparatus is worked, and a power governed in the following manner:

D is the boiler of a steam engine, which engine is not shown in the drawing, as it does not differ from others in common use. The engine gives motion to the drum E, around which is wound the chain *b*, *b*, *b*, which is connected with the scraper A, by means of tackle arranged in the ordinary way as shown in the drawing. The chain is conducted from the drum up through the column, or standard F, which supports the crane. In the side of this column there is an opening furnished with a pulley under which the chain is conducted; and after entering this opening it passes up through the column, and through the upper arm of the crane G, where it passes over a second pulley *c*, of a particular construction, to be presently described, and which I denominate a chain pulley. This latter pulley is fixed firmly upon its shaft or gudgeon, and upon one end of this shaft or gudgeon is the bevel wheel *d*, which gears into the wheel *e*, carrying the shaft *f*, which shaft has on its lower end another bevel wheel *g*. This latter wheel gives motion to a shaft *k*, between the main braces, or lower arms of the crane H, H. This shaft, and its appendages are for carrying the scraper out and in as may be required, the bevel wheel *g*, taking into a bevel wheel on the end of this shaft; the motion of the shaft *k*, is governed by a peculiarly constructed apparatus of my invention.

Fig. 2 is an enlarged view of this apparatus and of the shaft *k*, which croses between the main braces H, H, Fig. 1; *h* being a bevel wheel at one end of it, into which the bevel wheel *g*, Fig. 1 is geared, *i*, *i*, are the gudgeons which run in bearings in the arms H, H, I, is a pinion, which in my working machine, is nine inches in diameter, and gears into the spur wheel J, Figs. 1 and 3, three feet in diameter. Upon the shaft of this latter wheel is the drum K, Fig. 3, which is also situated between the main braces H, H, carrying chains in reversed directions which chains are attached respectively, to the opposite ends of the arms C, C, of the scraper; these arms rest upon the drum K, their under sides being ironed to prevent their wearing. Upon one end of the shaft *k*, Fig. 2, there is a friction belt *j*, *j*, which passes around a pulley *l*, *l*, shown also in the end view Fig. 4. The pulley *l*, *l*, and the bevel wheel which is firmly attached to it, run loosely on the end of the shaft *k*, and revolves, therefore without turning the shaft, unless the friction belt, (one end of which is firmly attached to the shaft), is tightened,

m, *m*, Fig. 2 is an arm which is in one piece with the shaft *k*, and is situated immediately within the friction pulley *l*, *l*, and to one end of this arm is attached one end of the friction belt *j*, *j*, the enlargement *p*, on the other end of the arm being employed merely as a counterpoise. The permanent attachment of the belt *j*, *j*, to the arm *m*, is shown at *n*, Fig. 4. The other end of the friction belt is attached to the crank lever *o*, and it will be manifest that by the turning of the shaft of this lever, the belt may be tightened. The apparatus for tightening this belt is constructed as follows: The shaft *k*, is hollow through the greater part of its length, and through this hollow passes a sliding rod, the head of which is shown at *q*, Fig. To this head is attached a lever for the purpose of moving it in or out. This lever is seen at *r*, Fig. 1, and is managed by a person standing on the platform L. The inner end of the sliding rod carries a rack *s*, attached to it through a slot in the shaft; this rack carries a pinion *t*, attached to the gudgeon of which; is the bevel pinion *u*, which gears into the segment *v* affixed by its center of motion to the shaft or gudgeon of the crank lever *o*, Fig. 4. By this arrangement when the sliding rod is drawn out the friction belt *j*, *j*, will be tightened, and this being firmly connected to the shaft *k*, will carry it around, and operate the scraper in such a manner as may be required. I employ a second friction belt *w*, on the shaft *k*, which belt is tightened by means of a lever *x*, Fig. 1, in a manner well known to machinists, the object of this belt is to hold the drum at any desired point.

The crane is turned around to either side or portion of the bank, from which earth is to be removed, by means of a chain or band, passing around the large horizontal band wheel M, attached to it, said chain, or band being guided to, and made to embrace it, by means of pulleys on the cap timber N, as shown in the drawing; the loop, or double-turn of this chain passes around a drum operated by the engineer, which has its motion reversed, or is thrown into, or out of gear, in any of the ordinary ways of effecting that object. The crank shown at *y*, Fig. 1 is that, which in the working machinery is connected to the steam engine, and communicates the motion from it to the machinery.

In Fig. 5, O, represents what I have denominated the chain pulley, together with a bevel wheel *d*, attached to its shaft, being an enlarged view of the same pulley and bevel wheel, shown at the top of the crane, immediately above the column, or standard F, and marked *e*, *d*. This chain pulley has excavations *z*, *z*, within its groove, of such form and size as alternately to receive the flat side, and the edge, of the links of a chain of the ordinary form, as shown at 6, I have found in practice this mode of forming a chain gearing to be much superior to any of the modes hitherto in use for that purpose, while it is, at the same time, much more simple.

In using this machine it is of course to be moved forward as the excavation proceeds, and this may be done either upon a temporary rail way, or upon the ground, as may be found most convenient. When brought into use it is necessary that it should be braced laterally, and this I effect by means of a projecting bench P, on each side of the carriage, sustained by a brace Q, and having at their ends a screw R, which screw is made to bear upon blocking placed under it for that purpose. By this provision all lateral motion is effectually checked.

Having thus fully described all those parts of my excavating crane which I believe to be new and indicated the manner in which these improvements are connected with the ordinary gearing, by which cranes are or may be operated upon by any motive power, such as steam, animals, or men, without deeming it necessary to offer any description of the manner in which the general gearing is effected, as this may be varied according to the judgment of the constructor, and is such as is well known to every competent machinist. And although the improvement consists mainly in the manner in which I employ the scraper for excavating, by means of the crane, I do not make any claim to the mere using of the scraper by means of the crane, this having been before done; but

What I do claim in the before described apparatus is—

1. The application of power to force the scraper forward against a bank in the act of excavating and to withdraw it at pleasure, by the aid of a barrel, chains, and other apparatus, constructed and operating substantially in the manner herein described, by which its sudden recoil will be prevented when it encounters any unusual resistance, and this I claim whether the apparatus be arranged exactly in the manner set forth, or in any analogous way, by which the same result will be attained.

2. I claim also the general combination of the friction belt around the pulley upon the shaft *k* and the apparatus for tightening the same, or of allowing it to run loose for the purpose and in the manner described.

WM. S. OTIS.

Witnesses:
THOS. P JONES,
W. THOMPSON.

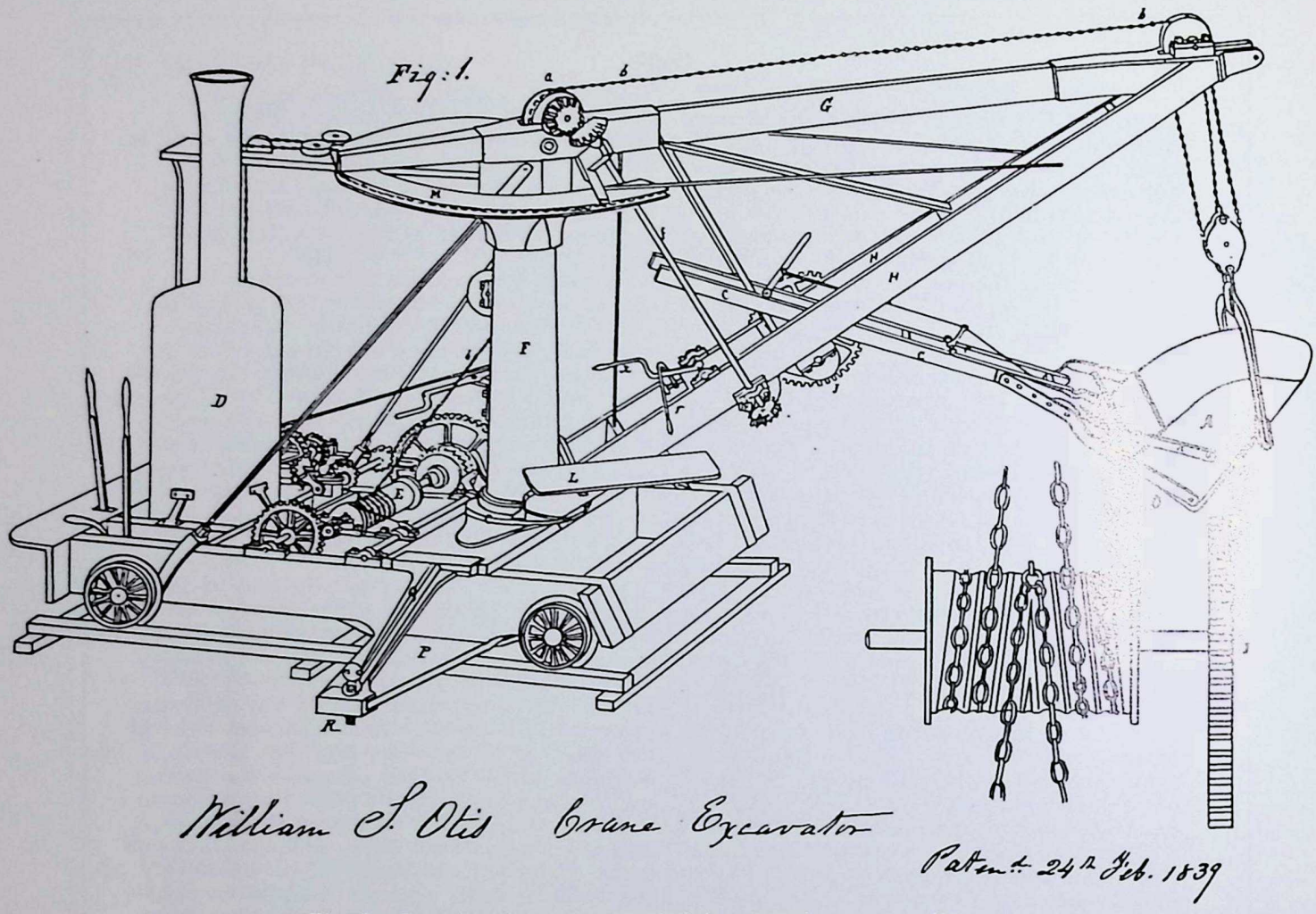


Fig. 8 Drawing that accompanied the second patent application.

pages occurred, from the inability to carry away the earth as fast as it could be dug up; yet in spite of these drawbacks, the machine has delivered as much as 100 cubic yards per hour, and the cost of working it, including fuel, wages, wear and tear and interest of capital, did not exceed fifty shillings per day.

"The machine is locomotive and has besides three kinds of motion, viz., the thrusting the shovel, the lifting it by the main chain when filled with earth, and the turning round on its centre, to deposit the material raised in the wagons, placed in a convenient position near it. The shovel when lowered, may be brought direct to the front frame of the machine, when it will be at an angle of about 40, or it may be worked horizontally directly in front, or made to scrape along each side, as the nature of the cutting demands. The motions are under perfect control by the lever of the machine, and the whole machine travels upon temporary rails laid for it.

"The excavator has been tried in America against a chain and bucket dredging machine and had been found much more economical in every respect, doing more work in a given time, at a less expense, and more satisfactorily."

The "American Devil"

The next record found of this Otis shovel is in the Newcastle "England" Advertiser during the year 1846.

"The American Excavator—A steam excavating machine, upon which the laborers have bestowed the name of the 'American Devil,' is now being employed at Hull in excavating the Victoria Dock. It was invented about eight years ago by a gentleman of New York and has been extensively used in the formation of American railways. It consists of a portable steam engine of about 16 h.p. and it is provided with a crane to which is attached a large square bucket of wood armed with 6 tusks. These tusks pierce the earth, which at once fills the bucket, two buckets filling an earth wagon. The machine requires 2 engineers and 3 men, and does the work of 30 men; filling about 200 wagons per day, each wagon containing about 7 tons of earth."

John Duncan, to whom reference has already been made, was granted an English patent for the Otis steam shovel on March 4, 1842, patent No. 9281. It is fair to suppose that Duncan was granted permission by Otis to take out this patent. It is not known whether the drawings accompanying Duncan's application were reproductions of the drawings from which the American machines were built or whether they were made from measurements taken from the machine in England.

A Penny a Yard

An authority says that "In two months the shovel worked a total of 37 days of 12 hours each, average 838 loads per day of 1-1/2 cu. yds. It

would require 180 men to excavate the same amount of material by pick and shovels. The machine costs about 1000 pounds and the cost of excavating by this means are:

	L	S	d
2 engineers	0	10	0
1 man to tend to the water	0	4	0
Coke, 8 or 10 cwt	0	10	0
Wear and tear	0	10	0
Investment 10%	0	5	6
Contingencies	0	5	0
	2	6	6

or at 1000 cubic yards per day equals about 1/2 d. per cubic yard." This represents about one cent in American money.

The same authority states that he measured the dipper and found it to be 4' wide x 5'6" long x 3'6" deep — one of these measurements evidently included the distance that the dipper teeth projected beyond the bucket. He goes on to state that the shovel could dig forward a distance of 10' without being moved, and he calculated its crowding capacity to be equal to 40 horsepower.

Shovel Building Enters Second Stage

O. S. Chapman married the widow of Otis in 1845. **[See Page 20]** Chapman had been a successful railroad contractor. He was with Otis when he conceived the idea of a steam shovel at Canton, Mass. in 1835. He had also later been associated with Carmichael, who owned the original shovels, in building other railroads and realized full well their labor saving value. He doubtless prompted his wife to apply for an extension of Otis' patent in 1853; later in 1867 he, too, was granted a patent No. 63857 on "certain improvements to the Otis shovel". **[See Appendix III]**

Some time during this period Chapman began to have the shovels made by the Globe Iron Works, later the John Souther Company, of Boston using the original Otis construction. **(Fig. 10)** The date is very uncertain because these later shovels were both advertised and referred to as the Otis shovel, although as time went on they were also designated as the Otis-Chapman, or the Chapman-Souther shovels. It is difficult to tell therefore, when a contractor writes, as one did in 1876, "I have used the Otis steam excavator for the past 20 years", or another in 1885 that he "has been handling the Otis machine for the last 30 years", whether they are referring to one of the two original shovels or those made later at Boston.

60 Years of the Same Design

The first advertisement of shovels made by the Globe Iron Works appeared in 1860, so it would be fair to assume the second period of their manufacture began in the '50s. Strange to relate, although these shovels continued to be built until 1912 or 1913, there were no radical changes in their design. They retained the same mechanism for swinging the boom, although two or three new types of dippers had been added.

The shovel was really fortunate in having a man like Chapman as its champion. He had made "his pile" as a contractor and was fully able to market the shovel, as his "sales talk" was based on the actual use of it.

(Continued on Page 22)

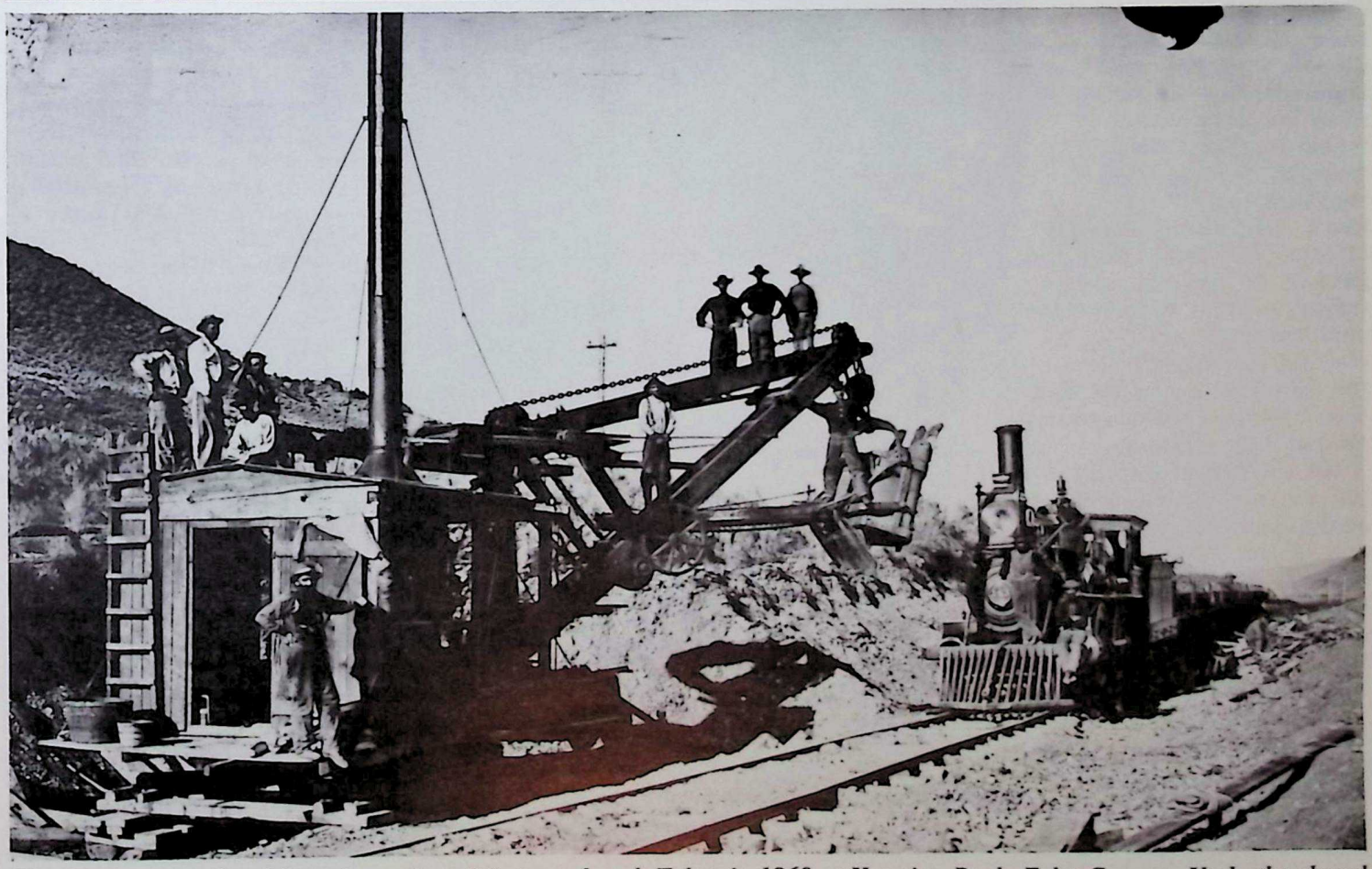


Fig. 9 Perhaps the oldest photo of an Otis-type shovel. Taken in 1869 at Hanging Rock, Echo Canyon, Utah, the shovel is loading ballast to fill an embankment.

Oliver S. Chapman

FROM the very beginning Oliver S. Chapman was closely associated with the Otis steam shovel. He had used if not personally operated, the first shovels made. Many years later it was he who revived their manufacture and brought them into general use.

Chapman and Wm. S. Otis were almost the same age, the former having been born at Belchertown, Mass. on August 11, 1811; each knew the other when, as contractors at Canton in 1834-35, they were engaged in the construction of the Boston and Providence Railroad.

Chapman was apprenticed to a wheelwright, but by the time he reached his majority had accumulated enough to build a saw mill. He evidently felt there was a greater opening in railroad construction, disposed of the mill and undertook the construction of the abutments for the Canton Viaduct. Here he first met Otis and no doubt knew all about the efforts of Otis and French to develop the former's idea of a mechanical excavator. Here also he met Miss Everett, the future wife of Otis, and was a guest if not a groomsman at their wedding.

He was later associated with the contractors—Carmichael, Fairbanks, and Otis during the construction of the Boston & Albany Railroad near Springfield in 1839, where he was responsible for the excavation of a cut some 60 or 80 feet deep through solid rock known as the Summit Cut. This work was not completed until 1841. He then retired for a few years on account of his health.

His first wife died during this period and he married the widow of his friend and fellow contractor Otis on March 23rd, 1844. At this time he also returned to contracting. In association with Daniel Carmichael he was engaged in the construction of the Vermont Central at Windsor, Vermont, where one or both of the original Otis excavators was used.

Other contracts were undertaken in rapid succession until he finally became able to finance jobs on his own. Some time about 1855-58 he secured a contract so large he needed excavators of his own. Having married Elizabeth Everett [illegible] he was in control of the patent rights, and had machines made by the Globe Iron Works, owned by John Souther, and located at the corner of First and A Streets in South Boston. Being well acquainted with the Otis Machine, he felt the need of some improvements in it and wanted an experienced designer to incorporate his ideas. He secured an extension of the Otis patent and was also granted a patent on his improvements.

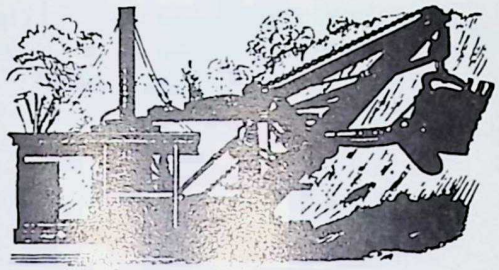
Thus after a lapse of some fifteen years the manufacture of the Otis Excavators was resumed and has continued ever since, though the center of the production of shovels has moved westward.

Chapman had his initial shovels made for his own use, but the Globe Iron Works (later John Souther & Co.) found such a demand for them that they continued making them for many years under a license or royalty from Chapman, until they went out of business about 1910. Chapman made his home in Canton, owning and living in the same house in which he resided as a young contractor in 1835. He died on February 8, 1877, beloved and highly respected by the community for which he had done so much. He is buried there in the cemetery in the same plot with Otis. ■

List of Separate Parts

of the

Otis Excavator



John Souther & Co.,

12 Post Office Square - - - Boston, Mass.

That duplicates may be ordered understandingly, and to facilitate our filling your orders, we furnish this list of the important parts of our Excavators enumerating the pieces in the order in which they are used on the shafts, commencing at the right.

2 Swinging plank shafts.
2 Swinging plank spindles.
2 Boxes, 1¾ inch holes.
2 Boxes, 1⅞ inch holes.
2 Swinging plank pulleys, 1¾ inch holes.
2 Swinging plank pulleys, 1⅞ inch holes.
1 Saddle casting on swinging plank.

1 Knock out shaft.
1 Knock out gear with pin.
2 Boxes for shaft.

1 Segment gear shaft.
1 Segment gear.
2 Boxes for shaft.
1 Finger gear and pin, works into segment gear.

1 Intermediate knock out gear and pin, works into large knock out gear.

1 Pawl casting, that pawls are pinned to.

One Post.

1 Swivel.
1 Chafing iron. (centre of post back.)
1 Kick out casting below chafing iron.

1 Shoe for deck casting, that crane braces set in.
1 Deck casting.
1 Step, bottom of post.

2 Angle irons at end of coffin plank.
2 Jack nuts for angle irons.
2 Jack screws for coffin plank.
2 Castings for diagonal bolts under coffin plank.
2 Jack plank castings running from deck plank to coffin plank.

2 Flange jack nuts for back screw planks.
2 Jack screws.

1 Forward axle.
2 Wheels for forward axle.
2 Boxes for forward axle.

1 Hind axle.
2 Wheels for hind axle.
1 Large move up pulley for hind axle.
2 Boxes for hind axle.

Chains.

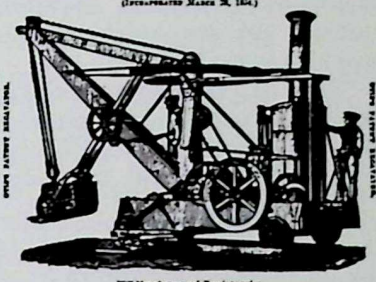
1 Endless chain for crane.
1 Moving-up chain.
1 Hoisting chain.
Arm and swinging chain.

☞ We have had experience with the different kinds of chain iron, and the iron we have used for a number of years makes probably the most durable chain in the market. We furnish all sizes.
The Excavator chains are made with especial care.

Fig. 10 *Two pages of an early catalog of John Souther and Co. The date of this catalog is uncertain, but the picture is the same as that on the advertisement which appeared in 1864, which would seem to link them together. The addresses on the two, however, are different.*

GLOBE WORKS.

(Incorporated March 28, 1854.)



Will Manufacture and Repair to order

LOW-PRESSURE MARINE ENGINES & BOILERS.

ALSO,

Locomotive, Stationary, and Portable

STEAM ENGINES.

OTIS'S

Patent Excavators and Steam-Dredges,

FOR DEEPENING RIVERS, DOCKS, HARBORS, &C.

SUGAR-MILLS, SAW-MILLS, & STEAM BOILERS

OF ALL KINDS.

Also, Original Machinery, at short notice, and in the best style of workmanship, on favorable terms. All Orders executed with dispatch. Orders from all parts of the country solicited.

Address

JOHN SOUTHER, or D. N. PICKERING,

President. Treasurer.

Foundry Street, South Boston, Mass.

Fig. 11 *In 1860 the Otis shovel was mentioned in a few advertisements but without illustration. The first picture of an Otis used in advertising is reproduced above. It appeared in 1862.*

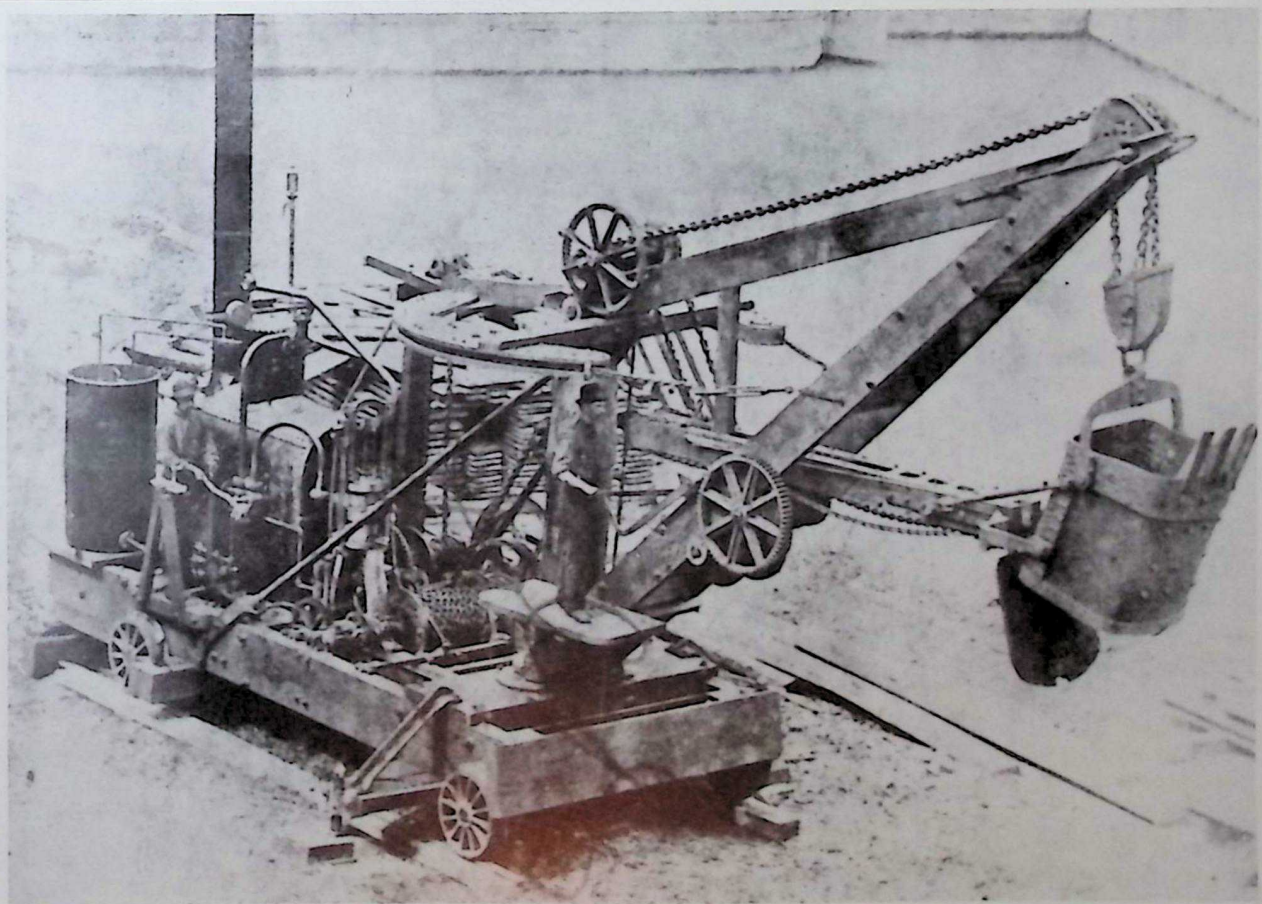


Fig. 12 *An early photo of an Otis-type shovel with Chapman improvements.*

Digging by "Stame"

Having read the first installment of "Digging by Stame," Sweney Munson, old time shovel man, sent us the following first-hand account of a railroad job on which an Otis-type machine was used.

"Prior to 1881 all traffic on the C. B. & Q. Railroad was ferried across the Missouri River, east of Plattsmouth, Nebraska. In 1880 a bridge was started across the Missouri at that point, and was finished in 1881.

"The West approach of the bridge butted up against a hill about 80 feet high, but sloped sharply to the North. A sharp curve from the approach of the bridge was made towards the North-West, and the cut for the curve was taken out with teams and wasted to the North. In the meantime the bridge was being built across the river, and a trestle 2000 feet long, and 20 to 30 feet high was built as the approach to the bridge from the East side. This trestle was afterwards filled in with dirt from the west side of the river.

"As soon as the bridge was finished, a track was laid from Plattsmouth, through the cut, over the bridge and trestle and connected with the C. B. & Q at Pacific Junction, Iowa. A side track was now laid on the south side of the main track in the cut, and chutes were built to carry the dirt down to flat cars on the side track, the dirt was then hauled across the bridge and plowed off with a locomotive and a long cable, and believe me that was some job of plowing. A lift of about 40 feet had been taken off by the teams, when they withdrew and an 'Otis' steam shovel was put in to finish the cut, which it did.

Digging to Dance Rhythm

"This machine looked just like the Schumacher picture shown on page 178 in the April Excavating Engineer. The operator stood way back on the right side of the boiler, where he could not see the dipper very well in the pit, so he had to depend on the craneman to tell him when to dig and when not to dig. The craneman had two levers to handle, one to crowd the dipper in and one to hold the dipper out when swinging, and it was comical to see him giving signs with his feet to the operator. To dig he would put his foot down on his toe, to swing right he would move his right foot to the right, and he would swing his left foot when he wanted the operator to swing to the left. That craneman was quite busy dancing a jig when the machine was digging; nevertheless, he got the job done.

"I was night-watchman on the bridge, and many times I would go to the job early and spell the fireman awhile, because the boiler was not a very good steamer and so was hard to handle.

"I don't remember the operator's or the craneman's names, nor do I remember if it was a company job, or a contract job. Those things did not interest me at that time. But I do remember that it was said to be the biggest steam-shovel job in the country, and I think it was, because an immense amount of dirt was moved."

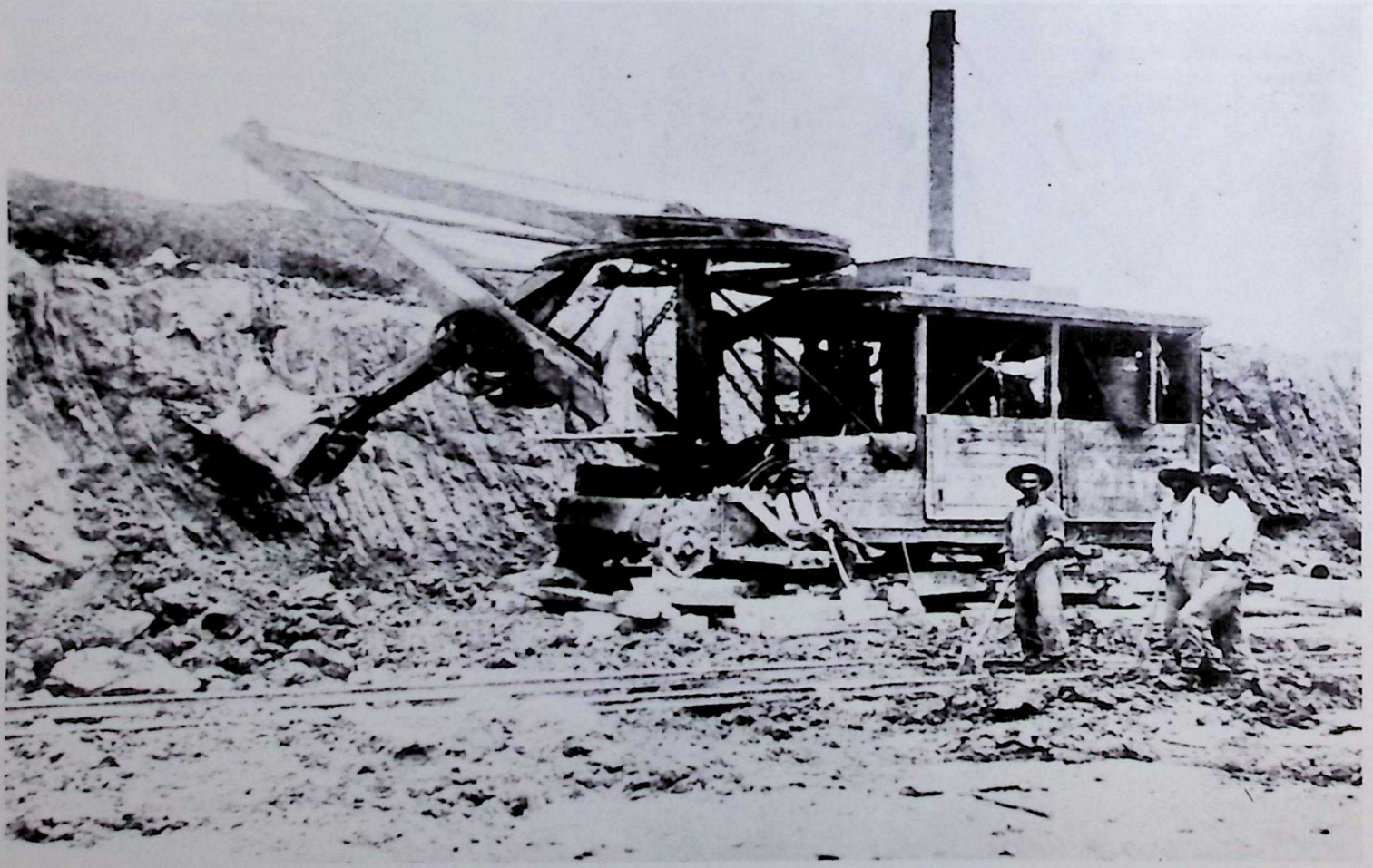


Fig. 13 Photo of a "Boston Shovel" as built by John Souther & Co. from E. A. Hermann's "Steam Shovels and Steam Shovel Work", 1894. This model probably represents the last version of the Otis-type shovels.

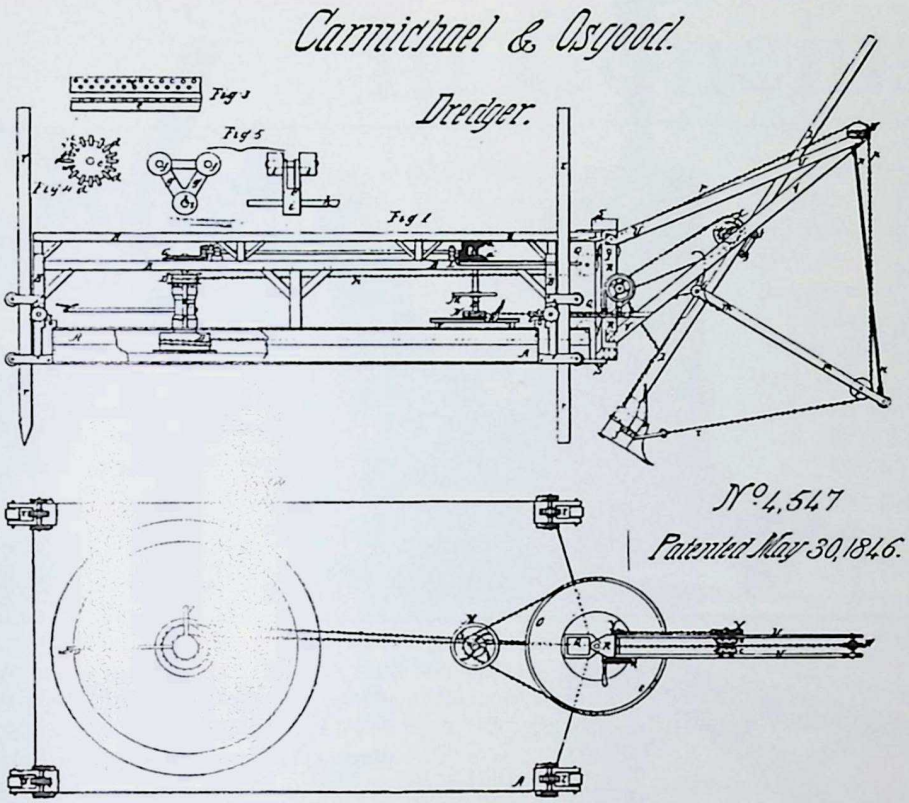


Fig. 14 In 1842, J. C. Osgood, of Troy, N. Y., met Carmichael and saw probably for the first time—an Otis shovel. They conceived the idea of a dredge with boom and dipper similar to those on the Otis shovel. Due to difficulty of securing fuel, two horses were to furnish the power.

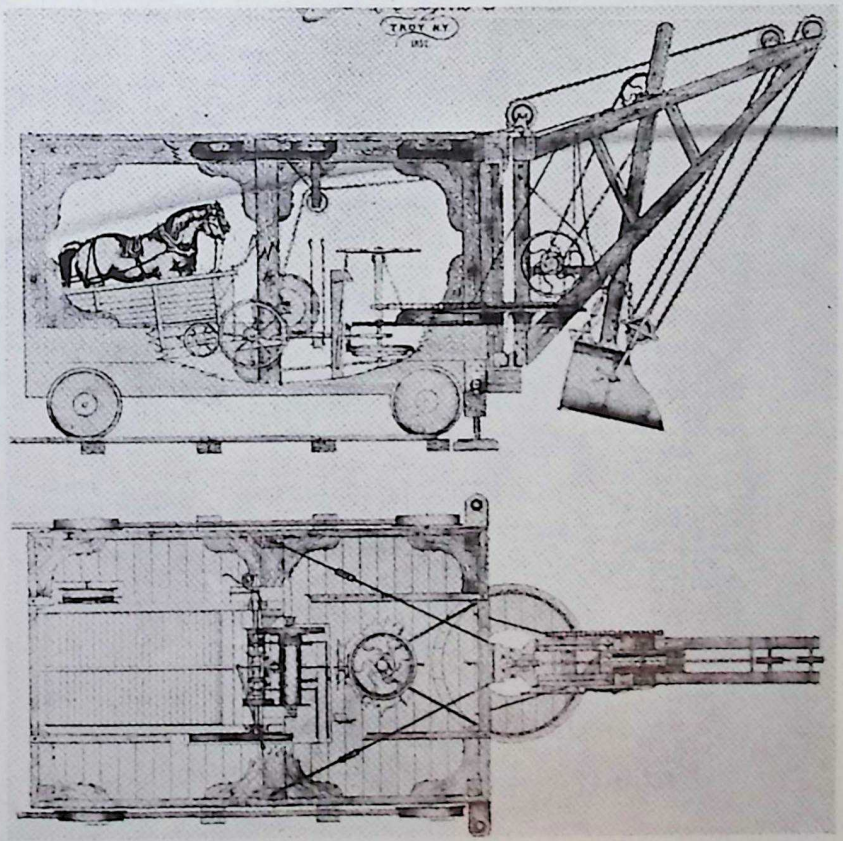


Fig. 15 This drawing, made in 1852, shows application to a land excavator of a machine similar to that patented in 1846 by Carmichael and Osgood.

The Power of Two Horses"

Jason C. Osgood of Troy, New York, was a builder of dredges, of the bucket type. In 1842 he met Carmichael and probably for the first time saw an Otis shovel. They conceived the idea of a dredge equipped with a boom and dipper similar to the Otis. They were granted a patent No. 4547 in 1846 covering "A certain new and useful improvement in the manner of constructing and working the machine for excavating and removing earth invented by Wm. S. Otis". Their design indicates, however, the application to a dredge, indeed this is borne out by the fact that they contemplated a difficulty in procuring fuel because of the use of the machine on water, and intended using "the power of two horses instead of steam". **(Fig. 15)**

England Slow to Manufacture Shovels

England followed in the footsteps of the United States in slighting this money-maker and road builder, in fact she was worse, for it was not until after some of Chapman's machines were imported about 1870 that her manufacturers began production.

Ruston-Proctor and Company had made about 17 shovels, 3 of 8 and 14 of 10 h.p. before the end of 1877. These shovels were supposed to be employed only for excavating sand, silt, loose shale and soft clay, because when one was needed in 1877 for "digging in stiff brown clay" certain changes were deemed necessary to strengthen the machine and it was then constructed as shown in **Fig 16.** It will be noted as far as later practice was concerned that this machine had approximately the same track gauge as the Chapman or Souther machines.

The steam shovel made by Alexander Chaplin and Company was very similar to the Ruston machine.

Before closing these remarks about England, it is interesting to note that patent No. 4480 taken out by Dunbar and Ruston in 1875 also covered patents on the first shovel of the revolving type. **(Fig. 18)** It was however 10 or 15 years later before full revolving shovels were built in England or America. ■

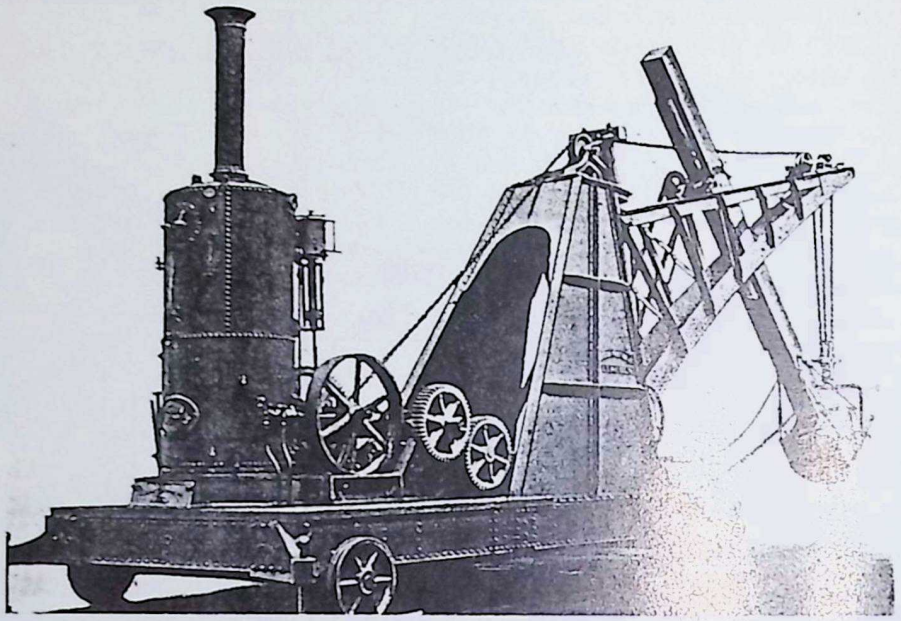


Fig. 16 Dunbar & Ruston patented this shovel in 1876. The revolving machinery is at the base of the mast and the machine was built entirely of steel. Over seventy of these machines were used in 1887 on the construction of the Manchester Ship Canal in England, the first large project upon which excavators were used in considerable numbers.

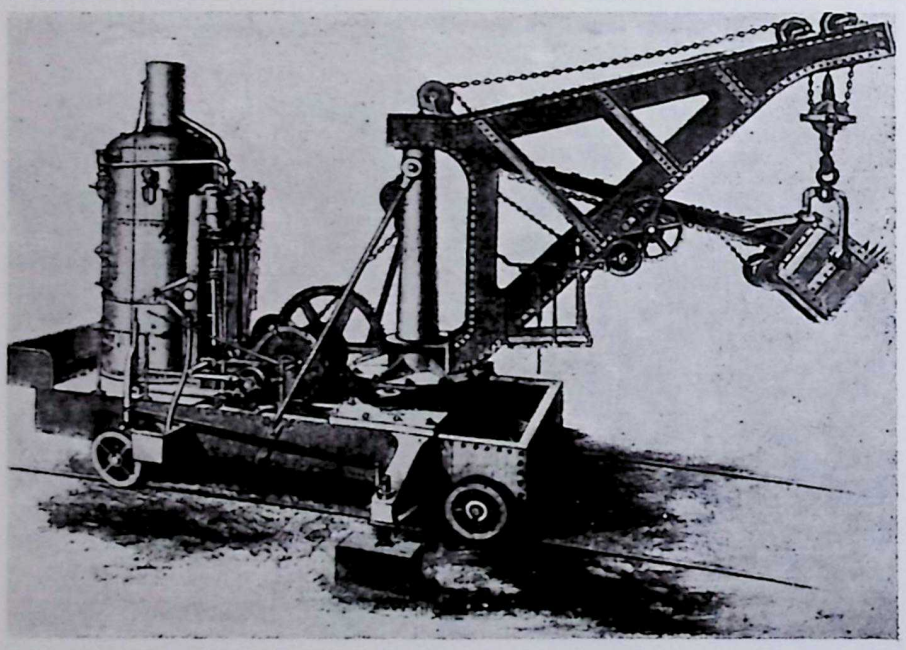


Fig. 17 Patented in 1877 by an Englishman named Chaplin, this shovel is very like the Otis except that the revolving mechanism has been moved to the bottom of the mast and steel seems to have supplanted wood in the construction.

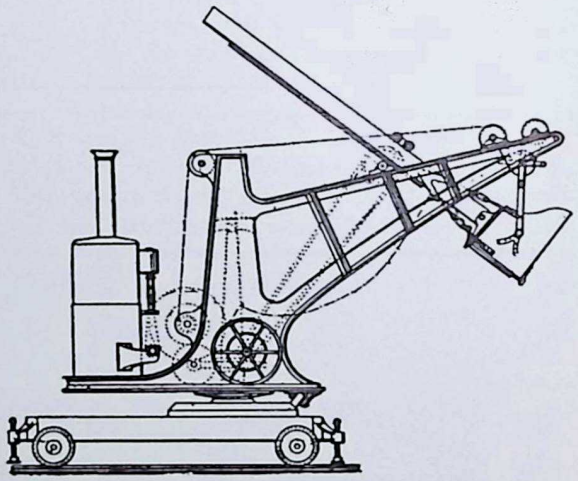


Fig. 18 In 1876, the English firm of Dunbar & Ruston was granted a patent for the full revolving shovel pictured here. No such shovels were built, however, until some 15 years later.

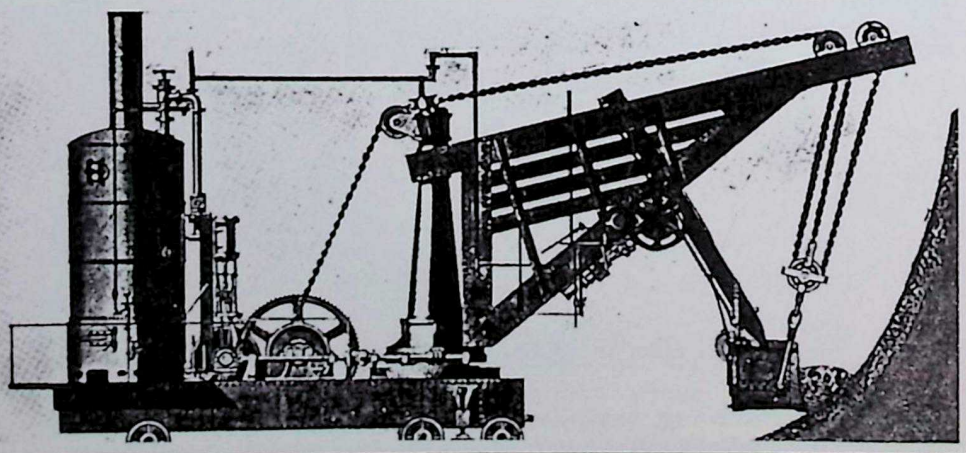


Fig. 19 The Barclay steam navvy was built by Barclay & Co. of Kilmarnock, Scotland in 1877. Similar to the Chaplin machine, it was the first with double cylinders for crowding.

In Conclusion

During the decade that began with 1880, shovel manufacture moved westward, the demand increased materially and the manufacture of shovels became enticing to those with ideas or capital. Soon such names as Owego, Barnhart, Marion, Bucyrus, Toledo, Atlantic, Clement, Ohio, Vulcan, Thompson, Victor, Osgood, and others became familiar, some to survive until today, some to be absorbed by more successful makes, and others to "go the way of the flesh."

Before concluding, it can be said that the original Otis shovel compared quite favorably with the modern shovel, if this comparison is based on the number of dipper swings per minute and not on the size of the machine, its horsepower or the capacity of the modern dippers. It must also be remembered that the facilities for removing the earth excavated by the dipper were in those days definitely poorer than today mand hence severely handicapped the shovel in reaching maximum production.

It must be remembered that the Otis shovels were fired with wood, that the engines were 9" x 12", that the steam pressure was not over 100 pounds.

The following are quotations from available records:

"The average time consumed by each revolution of the shovel is 45 seconds. Taking the result of one hour at 40 cubic yards, which is making liberal allowance for contingencies of all kinds." 1842.

"Which can dig and load 1000 cubic yards a day." 1853.

The shovel at first was only used in railroad construction or general excavations, or applied to dredges, and its value for other purposes was slow in being realized.

In 1877 it was first employed for stripping coal.

In 1886 a brick yard used a shovel to dig a clay bank.

In 1891 the shovel was first used to dig iron ore.

In 1896 to dig copper ore.

In 1905 began to be common in quarries.

The latest authentic record we have of an original Otis shovel is supplied by a nephew of W. S. Otis, who said that about 1893 while he was foreman in the Omaha shops of the Union Pacific he overhauled what was known as the No. 2 shovel, "though it was more likely the No. 3 shovel, as the No. 2 was sent to England." ■

Fig. 20 *The sport of steam shovel watching obviously began simultaneously with the invention of the machine!*

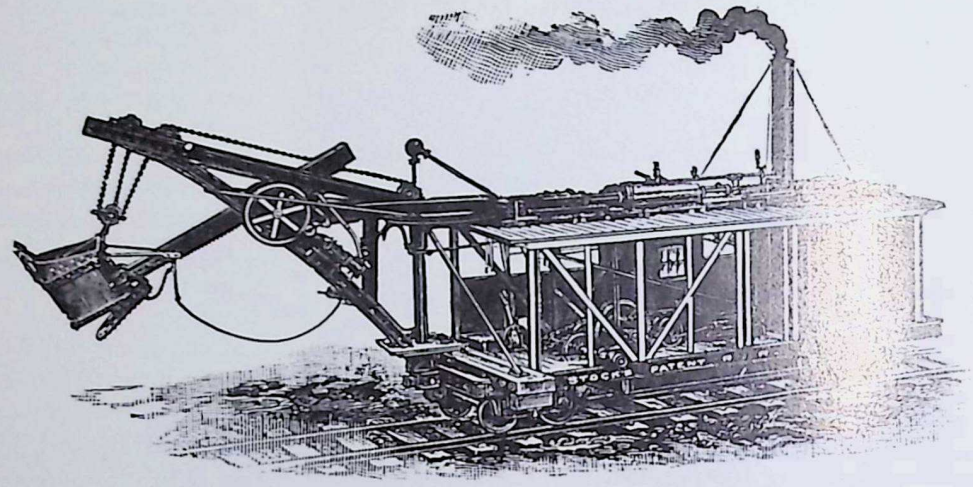
Appendix I

The name Hosea T. Stock may not be recognized by many, but he was a man who had a profound and important part in the evolution of the steam shovel. As witnessed in the account reproduced on the following page in the April 23, 1886 "Railroad Gazette", H. T. Stock arguably played a larger role in the early development of the steam shovel than anyone, including Wm. Otis! From serving as operator on the first Otis shovel, to developer of the first dipper dredge, to conceiving of the idea to mount steam shovel machinery on a standard RR flat car which ultimately led to the proliferation of steam shovels and their use, H. T. Stock played an important role up to his death on October 12, 1891. Many of the facts recounted below correct and clarify Farrell's writings in the original "Digging by Stame".

Stock came to Toledo, OH in 1876 where he eventually contracted with the Toledo Foundry & Machine Co. to build his excavators and dredges, ultimately becoming a vice-president of that company. In 1879 Stock joined with wealthy Toledo ship supplier Minot Wilcox to form the contracting firm of Wilcox & Stock Co. After Stock's death, the Toledo Foundry & Machine Co. continued to build Stock's excavators and eventually named them "Victor".

—HCEA

The Toledo Foundry & Machine Co.,



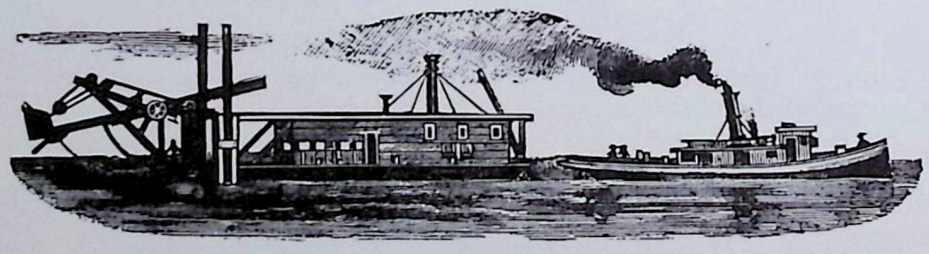
BUILDERS OF

STOCK'S PATENT

Railroad Excavator and Wrecker

DREDGES, PILE DRIVERS, HOISTING ENGINES AND HOISTING MACHINERY WITH PATENT FRICTION.

Marine Work and Repairs promptly attended to.



Steam Engines and Circular Saw Mills, Gearing, Pulleys, Shafting, Hangers, Grate Bars, Fire and Boiler Fronts, Potash Kettles.

ARCHITECTURAL and ORNAMENTAL IRON WORK,

AND ALL KINDS

IRON AND BRASS CASTINGS,

Cor. Water and Cherry Streets, near Cherry Street Bridge. } TOLEDO, OHIO. Telephone 298.

Ad from Polk's Toledo Directory, 1894.

"To the Editor of the Railroad Gazette:

Having seen of late in your valuable paper a good deal in regard to steam excavators, I wish to give the public some of my own experience. I do not know of any man living who has had more and longer practical experience in steam excavation than myself, either in operating or in building and rebuilding. I was employed by Messrs. Carmichael, Fairbanks and Otis on the Boston & Albany Railroad, in Springfield, Mass., in the spring of 183[illegible] and operated one part of No. 1 excavator a part of the season, when it required three men to handle it. The next year after the Springfield cut was completed, the excavator was removed to Westfield, Mass., where it was engaged in excavating some very heavy sand hills, and was at that time operated by an older brother and myself, it having been arranged to be operated by two men. On this work the No. 1 excavator did the biggest work it ever did, and often as high as 1,000 yards. We were often highly commended by Mr. Otis himself on the splendid performance of the excavator, and it was during the progress of this work, and before it was fully completed, that Mr. Otis died, November 13, 1839, at the early age of 26 years.

No. 1 excavator finally went to New Hampshire, when I lost track of it. No. 2 (built at the same time) worked at Worcester and Westfield on the Boston & Albany Railroad and from there it was taken to Washington Summit, the famous deep cut on the Boston & Albany, and from there it went to Brooklyn, N.Y., and was employed in cutting down the hills and filling up the low grounds about the city, and remained there until 1843, when it was taken to Canada on the deep cut of the Welland Canal, which Messrs. Carmichael & French had a contract to widen. I was sent there with it from Brooklyn, and remained there seven years. The excavator was put to work in the winter of 1843-44 in the bottom of the canal, but it proved to be a very expensive way of doing the work, as the material all had to be taken over the banks of the cut, which was about 60 ft. high. It was thought best to make a dredge of the excavator, and put the machinery on a boat, and mud scows were constructed with side doors to take the material from the dredge into overflowed lands caused by the back water of the canal. We thus, in the year of 1844, built the first swing crane dredge ever built in America, and the first that we have ever heard of in any country which had a single dipper and swung a crane from the center.

I afterwards worked two excavators at Suspension Bridge, grading the depot grounds for the Great Western Railway on the Canada side, and dumped about 300,000 cubic yards of earth over the precipice into the Niagara River. Thence, in the fall of 1856, I moved one of my excavators out on the Hannibal & St. Joseph Railroad, about 700 miles by rail and 40 by teams, and worked it there for nearly four years, and then changed it into a quartz mill and took it to the Rocky Mountains near Denver, where I worked it for two years. In 1861, Mr. Isaac Otis and myself took a contract to excavate a large quantity of material at Bergen Hill for filling the grounds of the Erie Railway. There we rebuilt an excavator and put in an iron mast and an iron-clad frame, and did the best work of any excavator up to that time. I afterward built five dredges for the Ohio and Indiana canals, which have worked successfully for a good many years. In the winter of 1877 I conceived the idea of building an excavator that could be mounted on a common flat car, to be self-propelling, with an adjustable jack arm to be folded up (and the crane lowered) when moving over the road, and succeeded in getting one up. I made a contract with the Flint & Pere Marquette Railway to load a quantity of earth for them for filling trestles and ballasting, and it proved quite successful; so much so that I built a second one and sold it to the Pittsburgh & Lake Erie Railroad, having made some improvements. I then saw another improvement that was wanted, a higher crane, provided with an arrangement for lowering down to pass low bridges. The arrangement proved a success. I then started to build iron cranes and iron masts, and make other improvements, putting in independent swinging engines and other small engines on the crane for handling the movement of the dipper. After building several excavators and making numerous improvements, and having at this time built 32 excavators and 18 dredges, I can say that there are dredges built after my plans, working now, that can excavate 2,000 yards per day in 12 hours, and excavators that can and have loaded 8 yards per minute upon cars, and have a record of 1,650 yards per day for a month, running only 6-1/2 hours each day. The cost of running this excavator for coal, oil and waste and foremen was $16 per day, or less than 1 cent per cubic yard. I propose to build excavators of wrought iron and steel that will dig anything except solid rock.

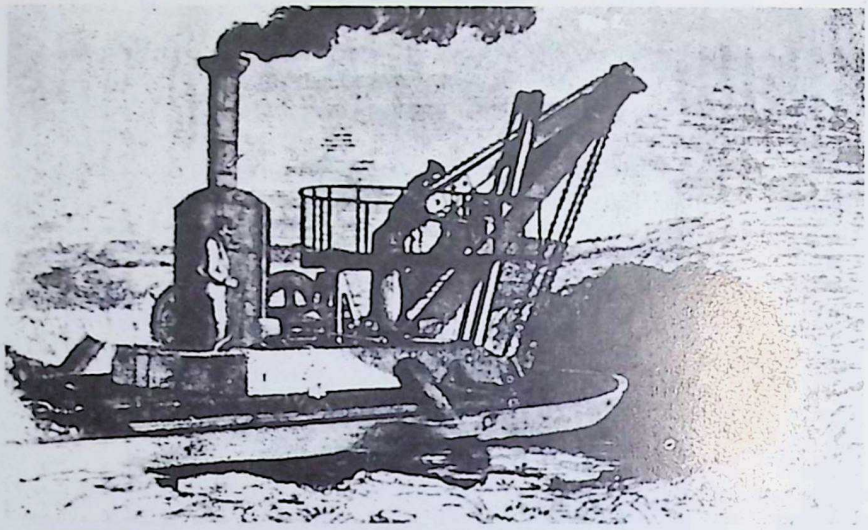
Among other excavators built at an early day, I superintended building one in South Boston for Chas. H. French, in 1849, to go on the Norfolk County Railroad in Massachusetts. This may well have been a rebuild of the very first excavator built in 1835 by Otis and French. About this time the firm of Eastwick & Harrison, of Philadelphia, built one or two; one was sent to France, I think, for the firm of Peto, Brassey, & Co. My brother went out with it and remained there three years.

H. T. Stock" ■

Appendix II

The following portion of an unpublished history of the Dunbar and Sullivan Dredging Co., written in 1987 by a Dunbar descendant, Dr. William Dugan, sheds some interesting light on the early dredging industry which not only ties directly into the first use of steam shovels, but also involves many of the same participants. The Dunbar & Sullivan Dredging Co., which has since gone out of business, dates its history back to 1844. Dr. Dugan's writings lends a personal, family touch to the early history of powered excavation, and the HCEA is grateful for his kind permission to reproduce a pertinent part of his history.

—HCEA



Drawing showing an Otis shovel mounted on a dredge. This machine, used in England in 1845, incorporated certain improvements made by J. B. Hyde. Note how revolving mechanism has been lowered.

Background 1844-1885

Probably little rationale for me to write a history of the Dunbar and Sullivan Dredging Co. My training has been in another ball park. Have no basic knowledge of engineering; and what I know about dredging derives from a summer spent with a survey team on Livingston Channel in 1933, from casual and occasional field observations, exposure at meetings of boards of directors, and conversations with family members and others closely allied to the Company. Surgical experience, a comprehensive knowledge of holistic medicine, and an ability to ttract and cozen patients do not easily translate into an understanding of difficult, complicated and highly specialized machines, nor of underwater and dockside adventures in extractions, deepenings, destructions, and constructions. If a man knows his limitations, why does he blunder forward? Presumably because he lacks judgement and common sense. This is principally a Dunbar history with Sullivan overtones which have long since faded.

The Welland Canal was completed in 1829. Soon there was need for maintenance work; it was impractical to pump the canal dry to do this. Horse powered dredges were introduced. Hosea T. Stock and Charles Howe French, brother to Mrs. Thomas Dunbar, who was Harris T. Dunbar's grandmother, founded a construction or dredging partnership in 1844. They conceived and had made the first steam dipper dredge at Allanberg, Ontario, on the Welland. It was an adaptation of the Otis Excavator installed on a barge using three posts or spuds, hand operated to stabilize it. Going back a step, the Otis Excavator had been patented by William Smith Otis, great grandfather of Oliver E. Dunbar, 24 February 1839. All this early Dunbar background ties in most explicitly with the work on the Welland Canal. When the Allanberg dredge appeared successful, immigrant workers on the Canal were much upset at the prospect of job losses, and threatened trouble. Until they moved to other fields the dredge was kept under wraps.

Thomas Dunbar, Harris T. Dunbar's grandfather, joined the management of Stock and French, and later took over the business. Stock left to "chase rainbows in the West and elsewhere. French was inducted to head a bank and a woolen mill at Canton and Stoughton, Massachusetts." Just when Stock and French pulled out leaving Thomas Dunbar solo is not clear in the material at hand—probably about 1860.

Thomas Dunbar, according to Harris T. Dunbar, always smiled when he talked about Charles French's ability on the deck of a dredge. "He was kind of a kid glove contractor." Thomas Dunbar liked to tell this story: He and an assistant were working at a repair while Charles French stood by, full of talk and advice, and wearing a light colored suit. Finally Charles French sat down carelessly and greased the seat of his britches, much to the derision and satisfaction of the other two. Thomas Dunbar said Charles French was a fine workman and cabinet maker, but a poor boss.

Thomas Dunbar was 25 years old in 1839, when his son, Charles, was born in Boston, Massachusetts. The family moved to Hamilton, Ontario when Charles was 14. For some time his father had been busy on Welland Canal work. He had dredged the canal, not Welland, from Hamilton to Dundas. Charles narrowly escaped drowning in Hamilton Bay the summer of arrival. He was resuscitated; he had visions of "sweetmeats" on a table as he slowly regained consciousness. Shortly thereafter began work with Hosea Stock who was building a section of the Grand Trunk R.R. at Niagara Falls, Ontario. What his duties were as a boy of 15 or 16 years, I do not know. But he acquired, either by choice or necessity, an interest in construction engineering.

In 1856 Thomas Dunbar moved his family to Buffalo. Son Charles went to Missouri, again with Stock, to work on the port at Hannibal, and St. Jeshep's R.R. Mark Twain had quit his boyhood home, and at this time was a Mississippi River Pilot, a young man in his early twenties. My imagination run riot 135 years later: youthful Dunbar and Mark may well have met on the west bank of the muddy Mississippi at the developing port of Hannibal. Charles gained additional experience in construction work, and perhaps in underwater diggings. ■

1882.—IMPROVED IRON STEAM SHOVEL AND DERRICK,

MANUFACTURED BY THE

INDUSTRIAL WORKS, - - BAY CITY, MICH

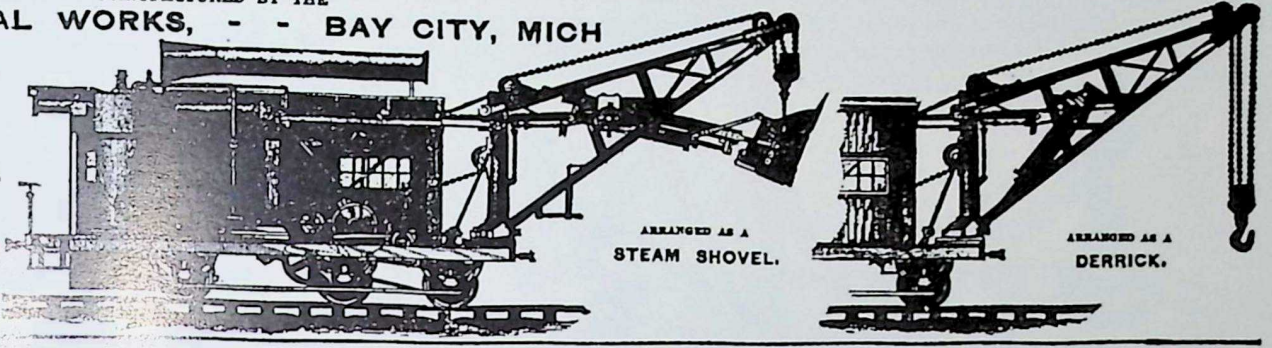
TURN-TABLES

OF

Iron and Wood.

C. R. WELLS, Sec'y, Bay City, Mich.

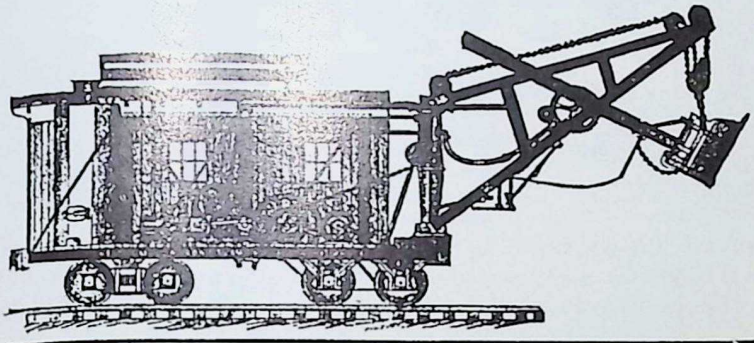
McMANN & BRO., 55 Gold street, N. Y.



ARRANGED AS A STEAM SHOVEL.

ARRANGED AS A DERRICK.

The "Thompson" Iron Steam Shovel and Derrick.



BUILT UNDER LETTERS PATENT BY THE

BUCYRUS FOUNDRY & MFG. CO.,

BUCYRUS, OHIO.

HAND CARS, PUSH CARS, BALLAST UNLOADERS,

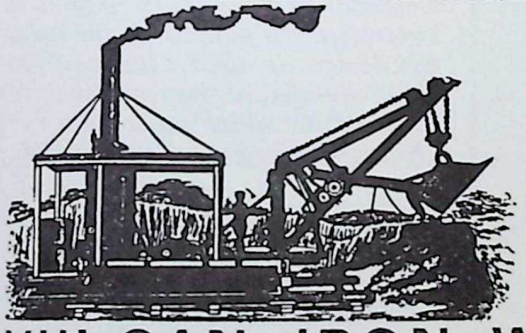
Steel Frogs & Switches, Loco. Cylinders & Drive Wheels,

AND EVERY VARIETY OF

CAR AND ENGINE CASTINGS.

NEW FRICTION CLUTCH STEAM SHOVEL.

VULCANIZED PAPER CLUTCH.



PATENTED MAY 3, 1882.

THE BEST

EXCAVATOR

IN THE WORLD.

VULCAN IRON WORKS,

BUILDERS AND PATENTEES,

OSWEGO, N. Y.

JOHN SOUTHER & CO., BOSTON, MASS.,

EXCLUSIVE MANUFACTURERS OF THE OTIS

Patent Steam Excavators.

WITH CHAPMAN'S IMPROVEMENTS AND DREDGES

RAILROAD STEAM EXCAVATORS,

Railroad Car Pile Drivers, Steam Pile Hammers.

VULCAN IRON WORKS, CHICAGO, ILL.

DREDGES

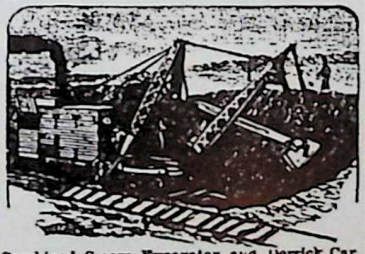
guaranteed to excavate 50 per cent. more material from hard bottom than any other machine.

EXCAVATOR

has a capacity of 4 cubic yards per minute in gravel. Has proved very efficient and desirable in the hardest hard-pan. Derrick lifts 8 tons.

Circulars furnished.

COMBINATION DREDGE.



Combined Steam Excavator and Derrick Car.

OSGOOD & MACNAUGHTON,

ALBANY, N. Y., PATENTEES.

Successors to RALPH R. OSGOOD, Troy, N. Y.

WILLIAM SELLERS & CO.,

PHILADELPHIA.

Iron and Steel Working Machine Tools, for Railways Machine Shops, Rolling Mills, etc.

PIVOT BRIDGES---SHAFTING.

TWEDDLE'S HYDRAULIC RIVETER.

In 1872 the Railroad Gazette states that they frequently received requests for information as to where steam shovels could be bought, which they were unable to answer because of insufficient knowledge. Ten years later, however, as indicated by this page of the Gazette, its readers were getting plenty of information from early manufacturers.

Appendix III

Listed below are brief company historys of the North American manufacturers of railroad shovels. Included are representative drawings of their earliest machines listed in chronological order of introduction. — HCEA

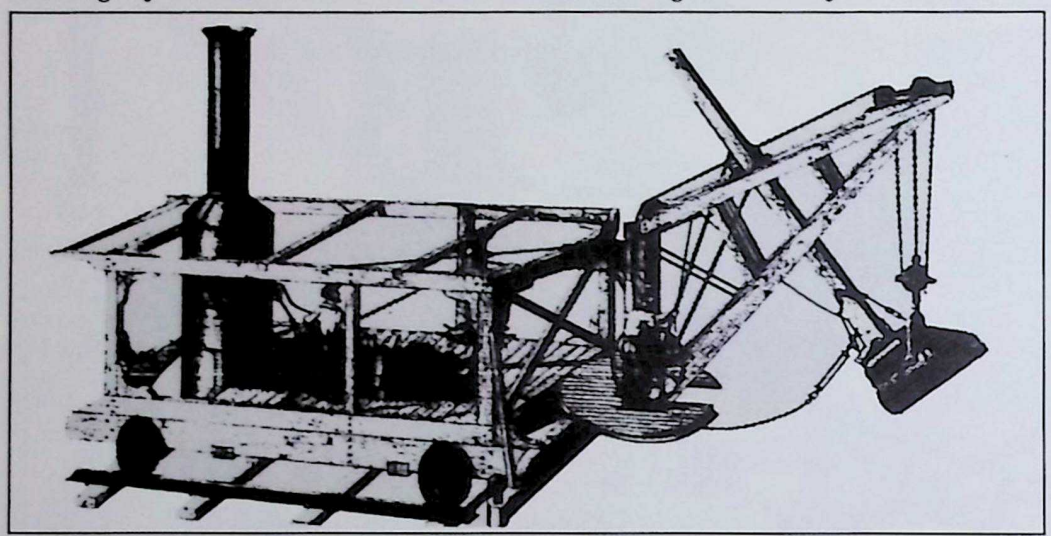


Photo 1
In 1846 Daniel Carmichael and Jason Osgood patented this railroad excavator. Osgood built the machine at the famous factory in Troy, NY.

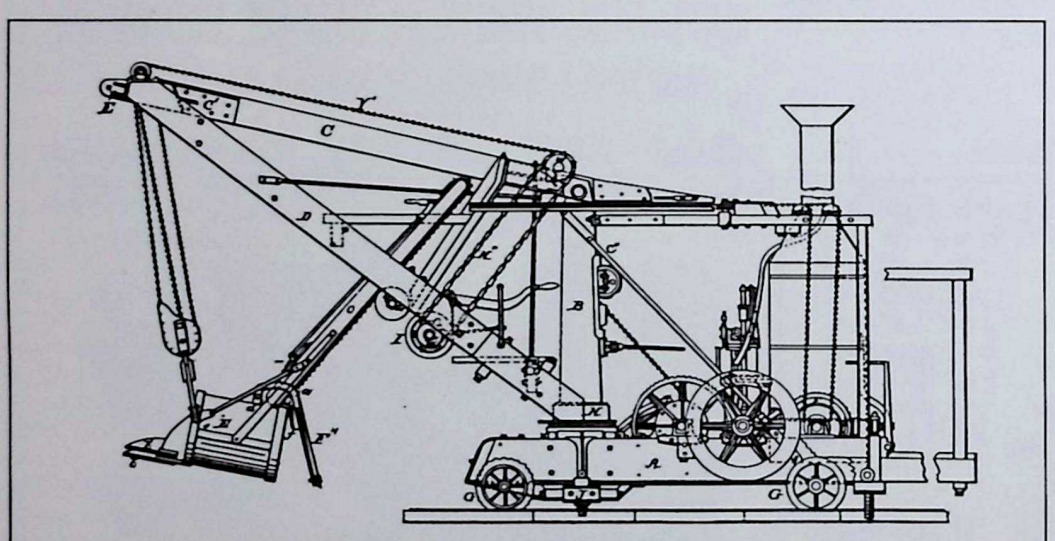


Photo 2
After William Otis' friend Oliver S. Chapman married Otis' widow, he controlled the patents on the original design. In 1867 Chapman patented significant improvements for the machine which included a very effective chain crowd mechanism.

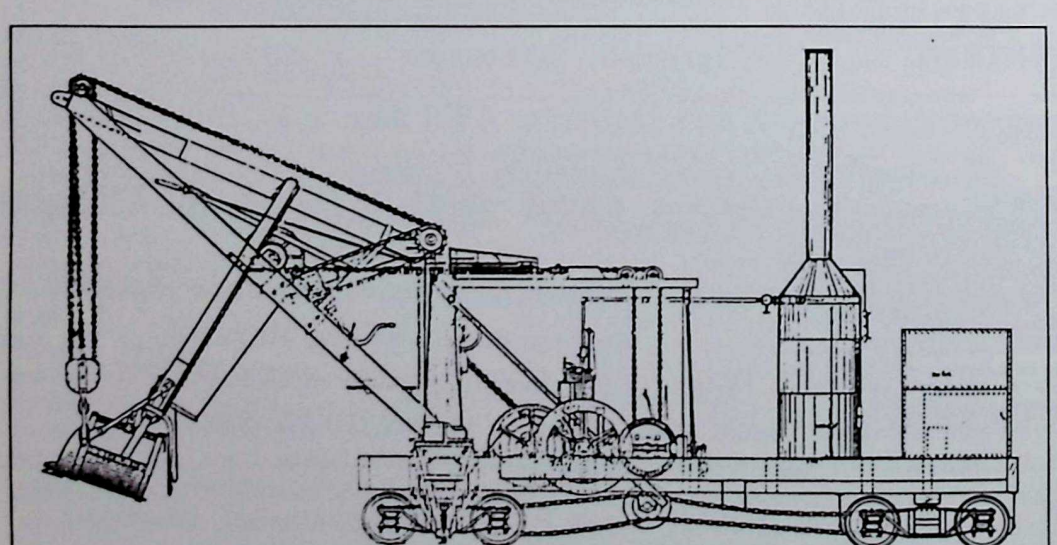


Photo 3
Throughout the 1860's and up until about 1912, the Globe Iron Works (later becoming the John Souther Co.) of Boston, MA, built the Otis type shovel with Chapman improvements. The largest version is illustrated with a 2 cu. yd. capacity. All Otis-type shovels were frequently referred to as the "Boston shovel".

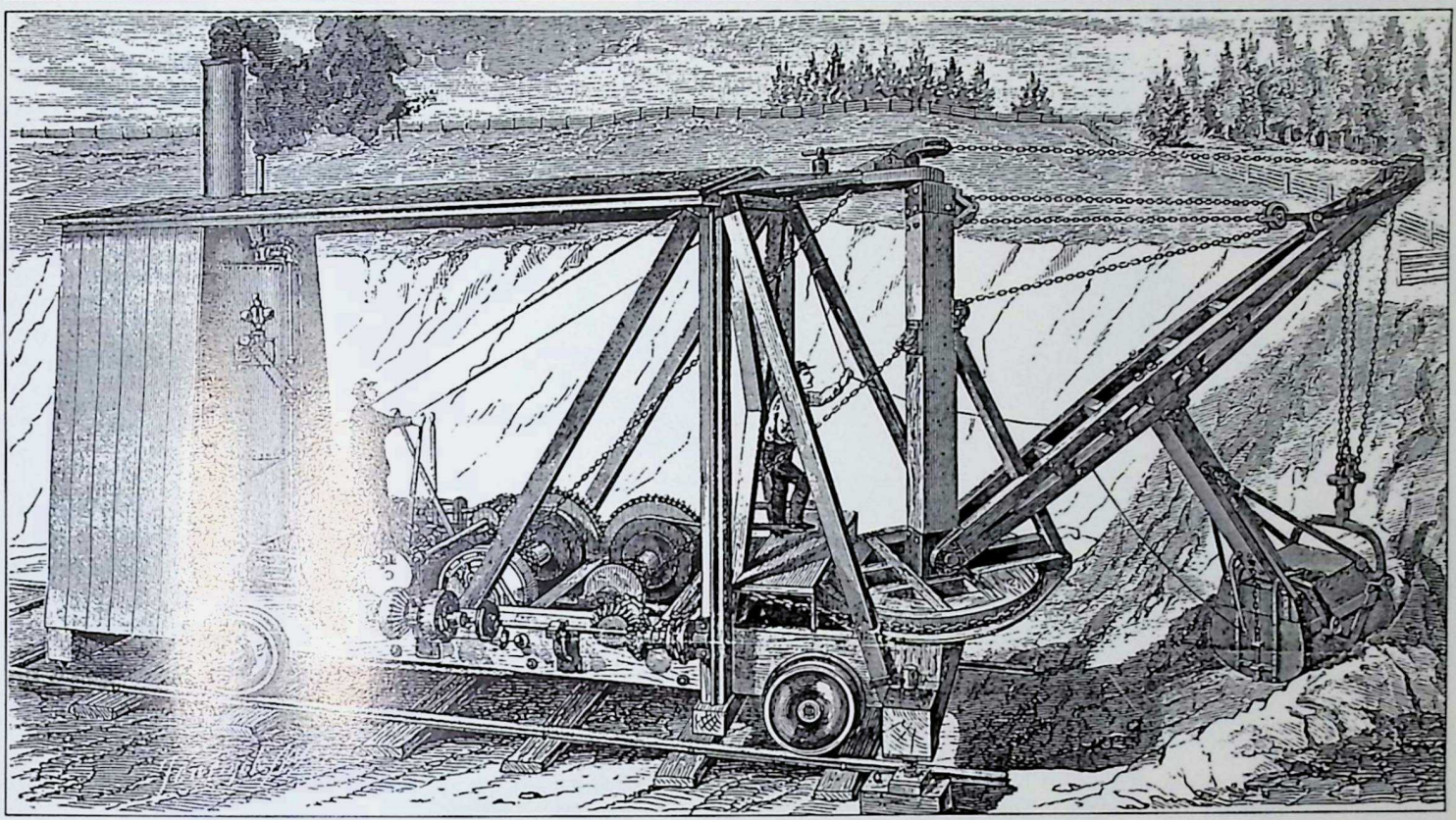


Photo 4 *Patented in 1870, the Sage & Alger shovel, known as the "Oswego boom machine", was built by the Vulcan Iron Works of Oswego, NY. The early machines were not a success, primarily because they lacked the ability to crowd the bucket. The factory, owned by John King, burned in 1895 and was not rebuilt.*

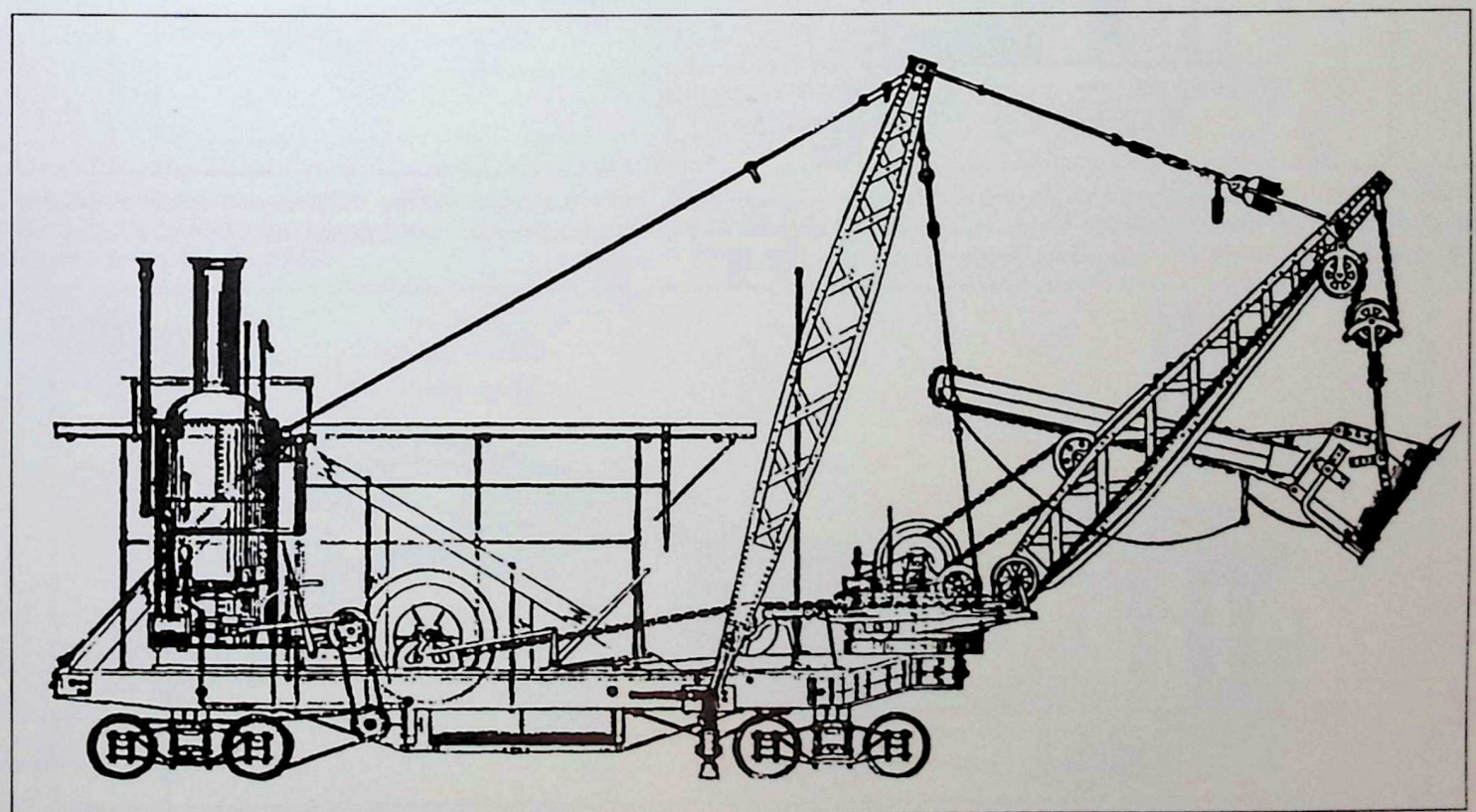


Photo 5 *In 1875 Ralph R. Osgood applied for a patent for an A-frame and boom type excavator. This was a much improved design and following the final patent expiration in 1892, nearly all excavator manufacturers used some form of this boom arrangement. Several of these machines were used on the French attempt at digging the Panama Canal in the 1890's. The Osgood factory burned in 1907 and was not reconstructed.*

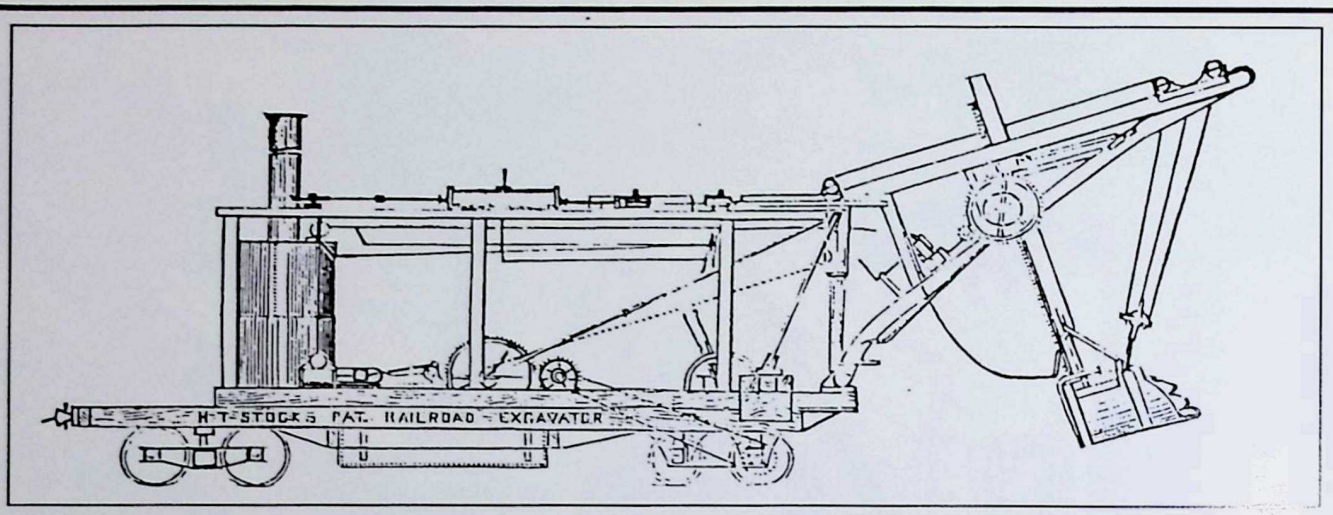


Photo 6 *The crucial involvement of H. T. Stock, in the development of the steam shovel was documented in Appendix A. In 1877 his idea to mount shovel machinery on a standard gauge R. R. flat car led directly to the growth of shovel manufacturing and coincided perfectly with the prolific growth of railroad construction in North America. The machines were built in Toledo, OH by the Toledo Foundry & Machine Co.*

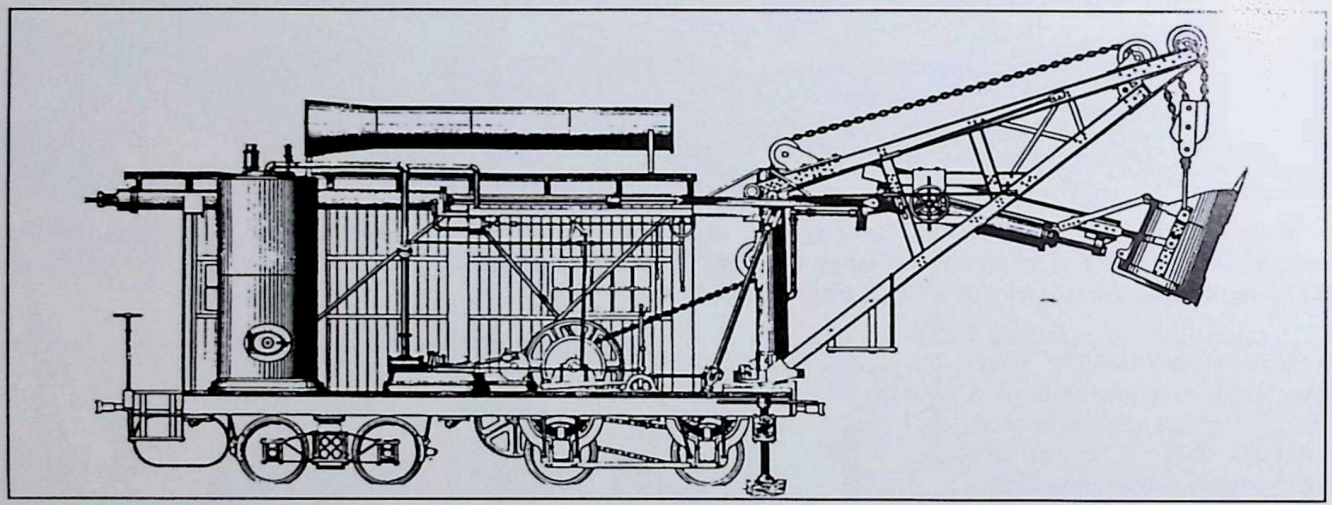


Photo 7 *Dill's excavator, named first for engineer Thomas Dill, later was named the "Clement" after President James Clement of the Industrual Works Co. of Bay City, MI. The excavator was introduced in 1881 for work on R.R. construction but its life was short, being discontinued by 1890.*

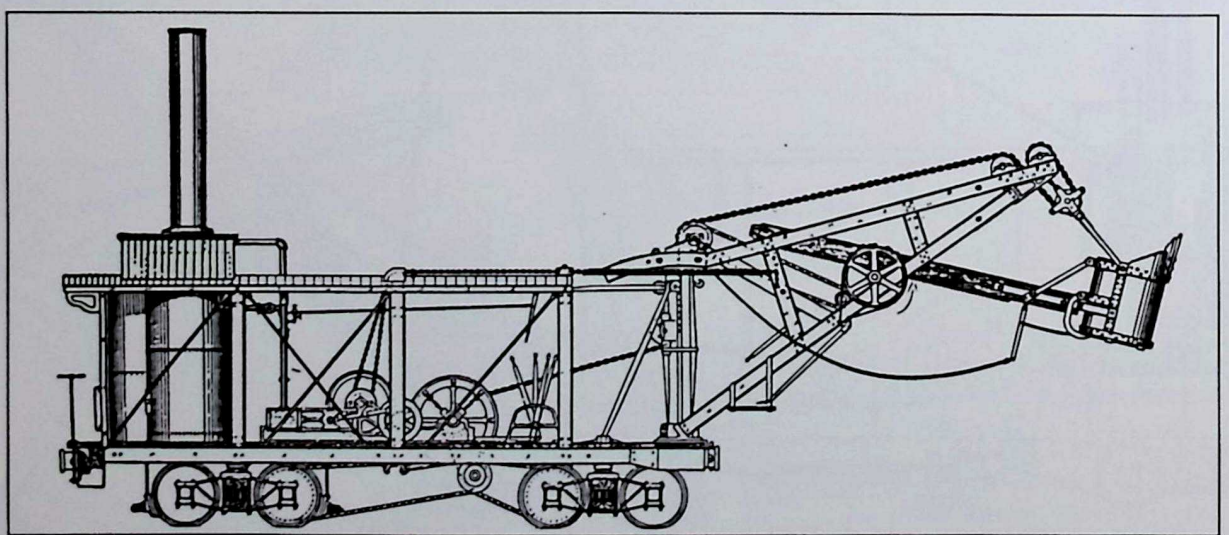
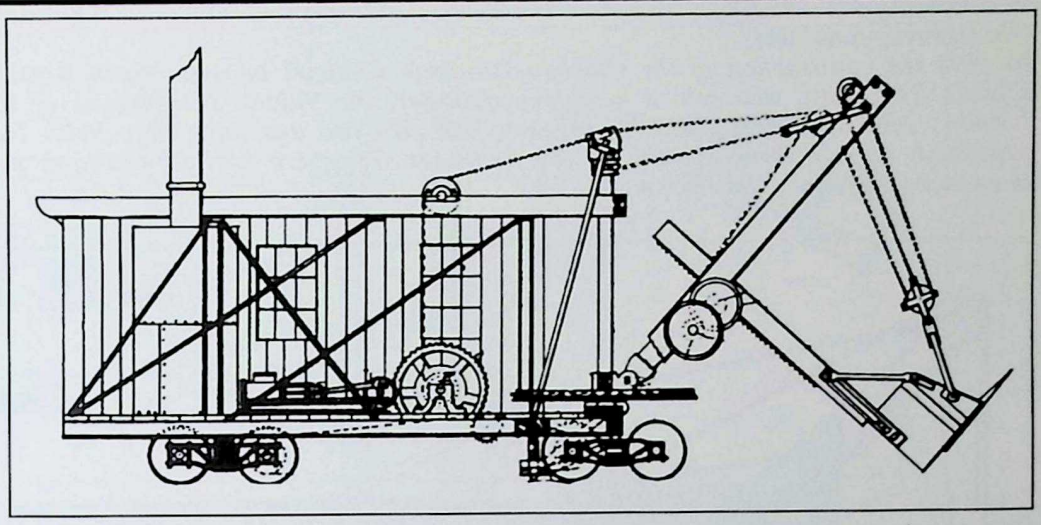


Photo 8 *The Bucyrus Foundry & Manufacturing Co. of Bucyrus, OH moved into the excavator field when it introduced the "Thompson Iron Steam Shovel and Derrick" in 1882. Named for chief engineer John Thompson, the machine was patterned after Stock's machines. When the first shovel was delivered to the Northern Pacific R. R., a proud tradition of excavator manufacturing was begun that continued up to the present time by what is now known as the Bucyrus-Erie Co.*

Photo 9
Henry Barnhart introduced his first machine in 1883. Known as "Barnhart's Steam Shovel and Wrecking Car", the machines were first built at the Huber Manufacturing Works in Marion, OH. In 1884 Barnhart joined with Edward Huber and George King to form the Marion Steam Shovel Co. This company, known today as the Marion Power Shovel Co., enjoys a legacy of excavator manufacturing that almost exactly parallels that of the Bucyrus-Erie Co.



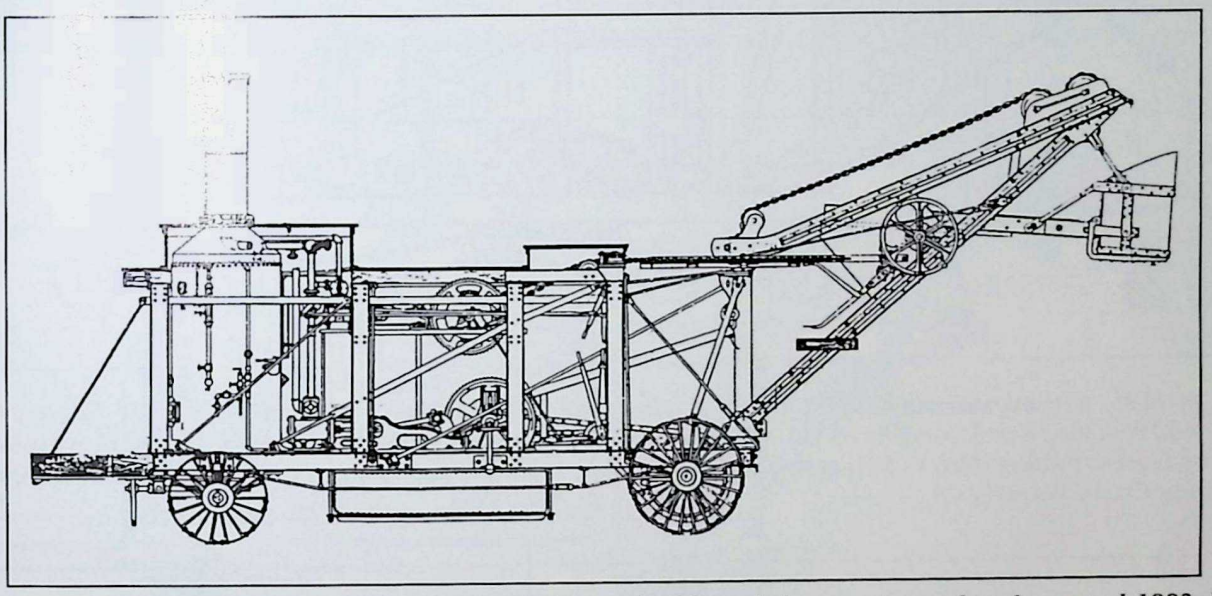


Photo 10 *The Vulcan Iron Works Co. of Toledo. OH began building their own steam shovels around 1883, but at least one account credits Vulcan with building shovels for H. T. Stock. Builders of "Giant" and "Little Giant" railroad shovels, Vulcan was at one time a leader in steam shovel sales. Vulcan was eventually bought out by the Bucyrus Steam Shovel Co. in 1910.*

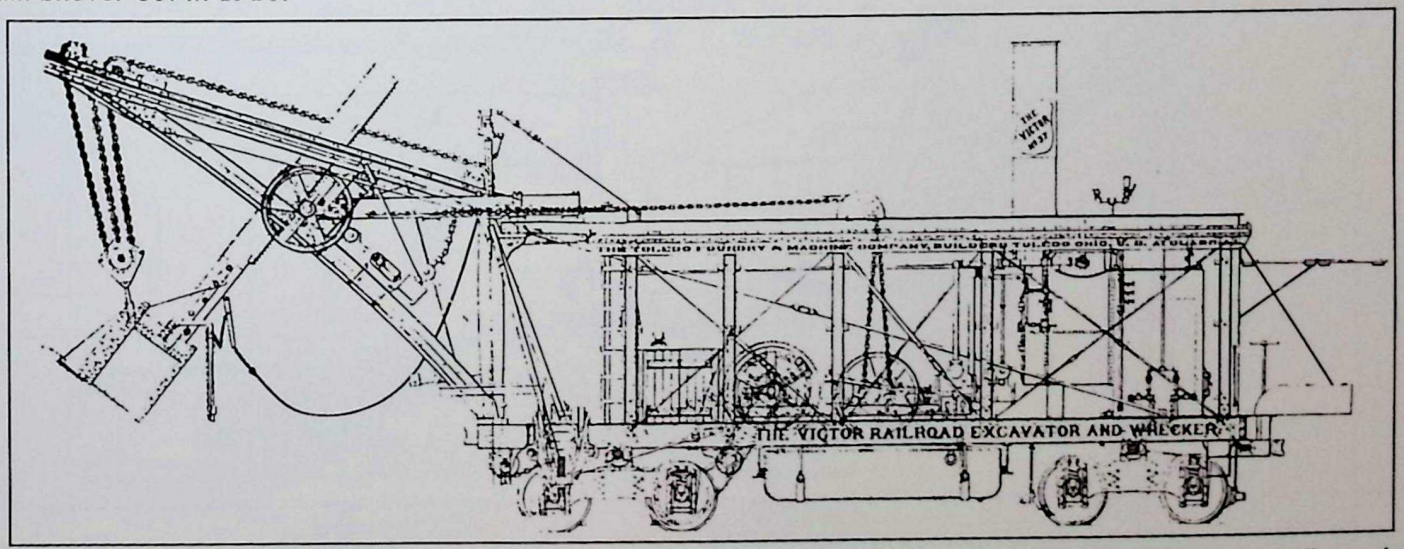


Photo 11 *The Toledo Foundry & Machine Co. of Toledo, OH, original builders of "Stock's Patent Excavators", continued to build railroad shovels of various sizes. Beginning in 1886, they referred to their machines as "Victor" shovels. Although there is no proof that they built any excavators after WWI, Toledo Foundry & Machine Co. continued to advertise their shovels well into the 1920's.*

(No Drawing Available)
In 1895 the construction of the Chicago Drainage Channel became North America's first large scale use of steam shovels. This same year saw a local manufacturer, the Vulcan Iron Works of Chicago, IL, build the "Warrington Pattern" railroad shovel. Evidence suggests that only two machines were built, but the Vulcan Iron Works became a prominent manufacturer of pile driving hammers. They are still in business today in Chattanooga, TN and still manufacturing foundation equipment.

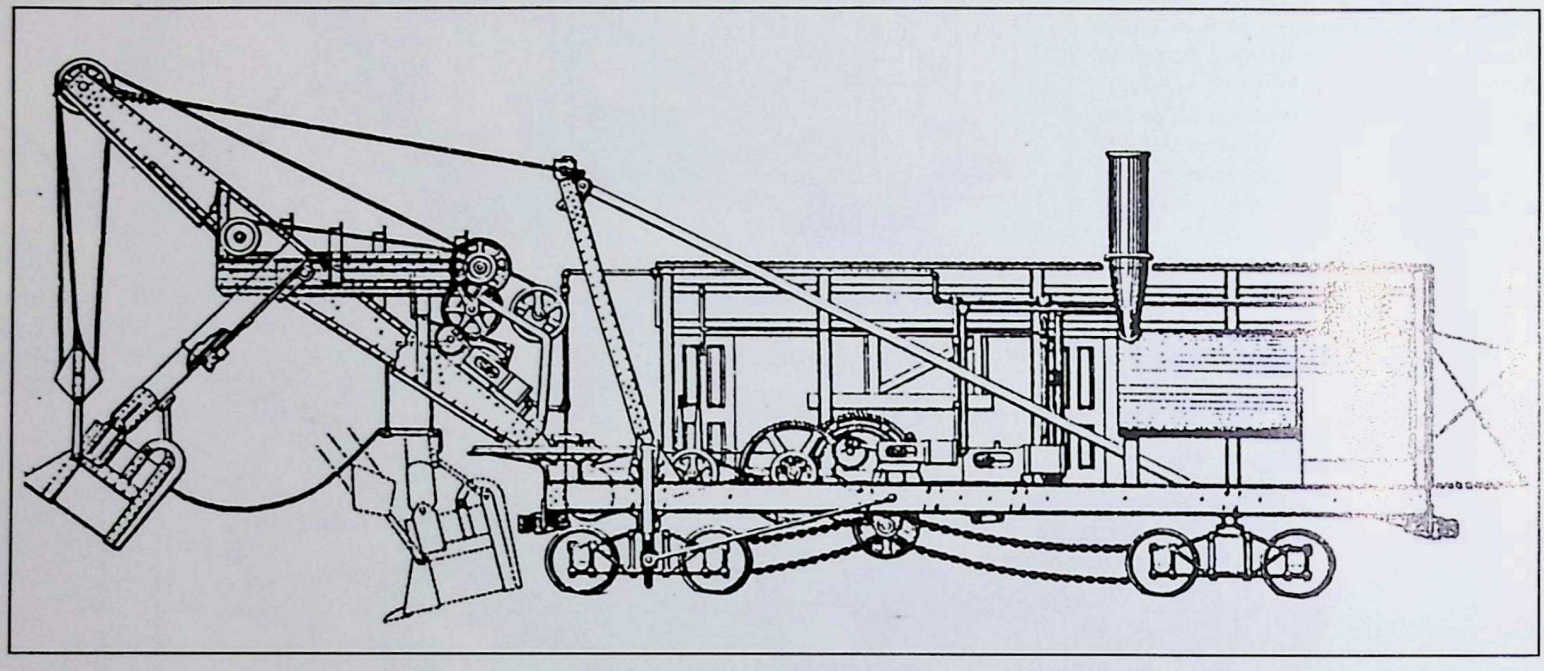


Photo 12 *In 1895, Commander Richard P. Thew of Cleveland, OH had built the first successful full-revolving steam shovel. Around 1900, the Thew Steam Shovel Co. of Lorain, OH began building several sizes of railroad shovels incorporating their patented level-crowding design. Still manufacturing cranes, the company is known today as the Lorain crane division of the Koehring Co. of Waverly, IA.*

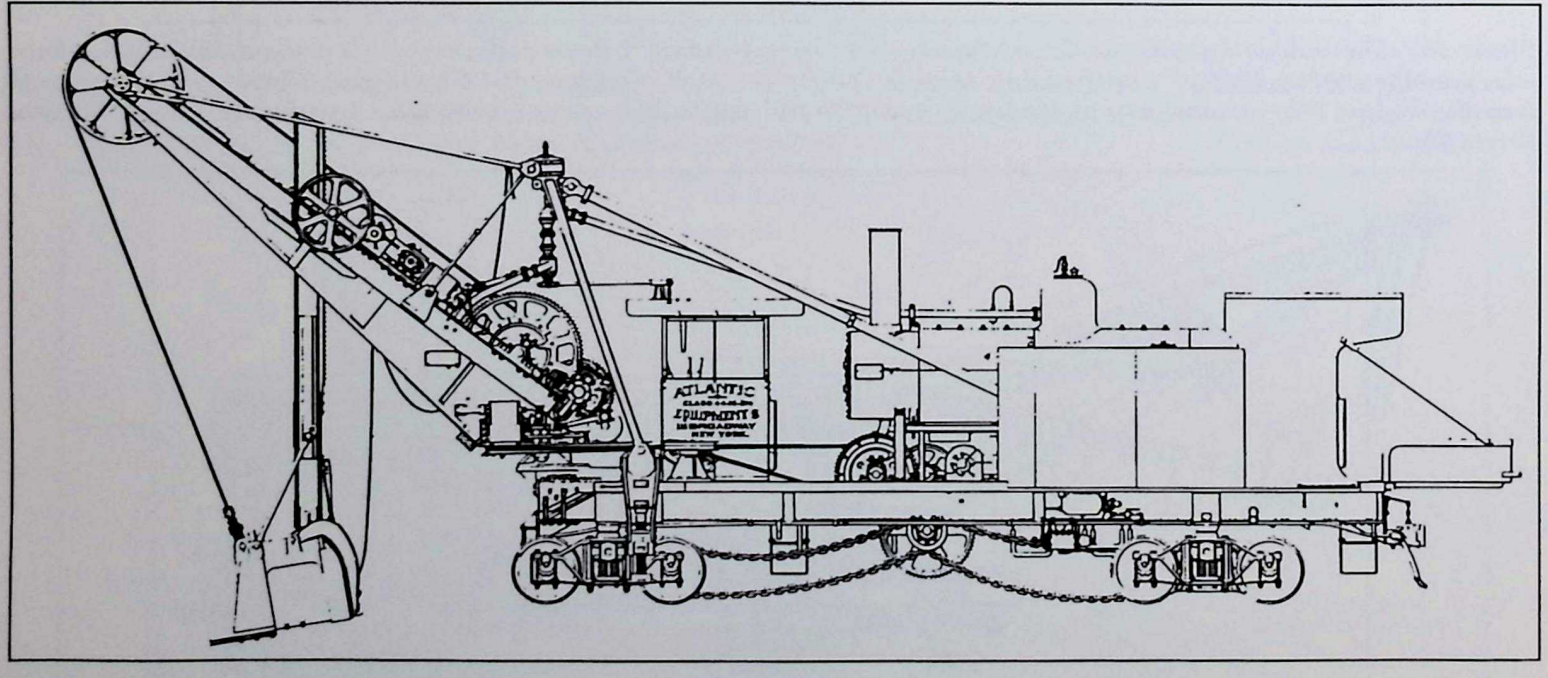


Photo 13 *The Atlantic Steam Shovel was patented in 1902 by Arthur W. Robinson, former chief engineer for the Bucyrus Steam Shovel and Dredge Co., and built by the newly formed American Locomotive Co. The most distinguishing feature of the Atlantic shovels was the incorporation of a direct wire rope hoist. The rights to the Atlantic steam shovel were bought by the Bucyrus Steam Shovel and Dredge Co. at the same time Bucyrus bought the Vulcan Steam Shovel Co. of Toledo, OH.*

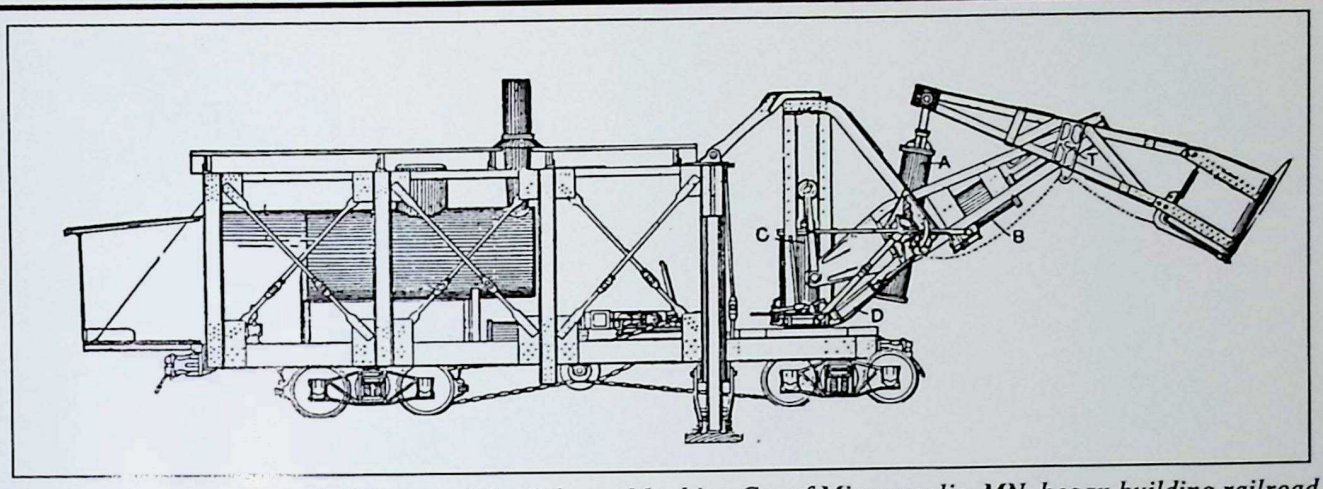


Photo 14 *In 1903, Frederick O. Kilgore of the Kilgore Machine Co. of Minneapolis, MN, began building railroad shovels of a very unique design. Instead of chains and cables, all functions of the shovel were performed by direct-acting steam cylinders. The machines were not very successful, and production ceased in 1905, primarily because of the machine's limited crowd and hoist reach.*

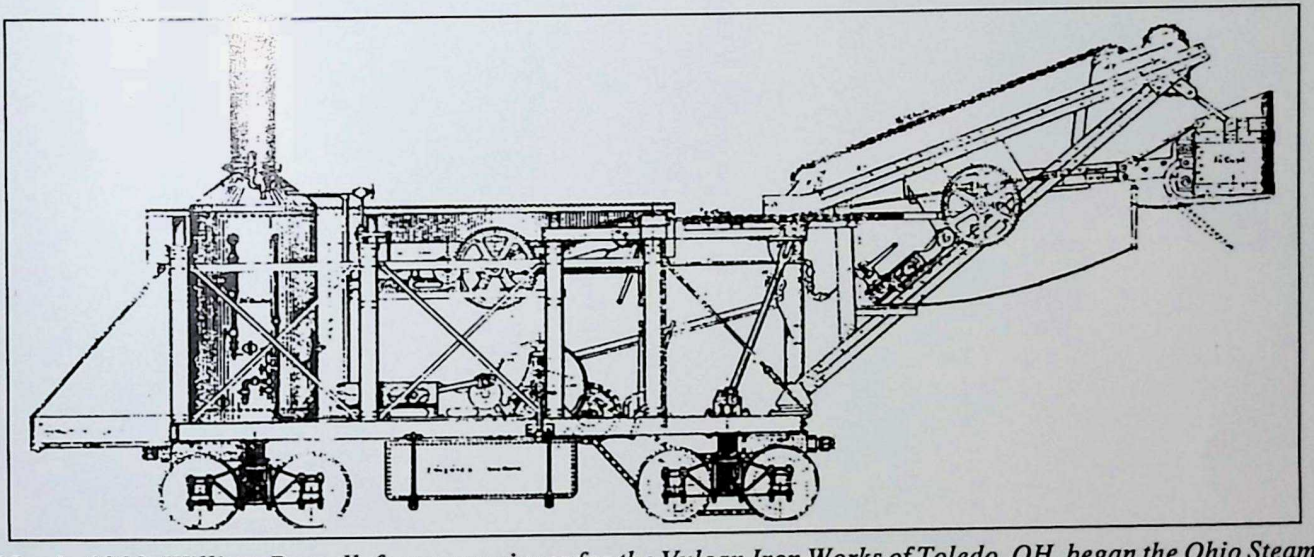


Photo 15 *In 1903, William Russell, former engineer for the Vulcan Iron Works of Toledo, OH, began the Ohio Steam Shovel Co., also of Toledo, OH. Russell's railroad shovels were near duplicate copies of the Vulcan "Little Giant" which he had previously designed for Vulcan. The Ohio Steam Shovel Co. moved to Cincinnati, OH, and then eventually moved to Lima, OH, where it evolved into the Ohio Power Shovel Co., first builder of Lima excavators.*

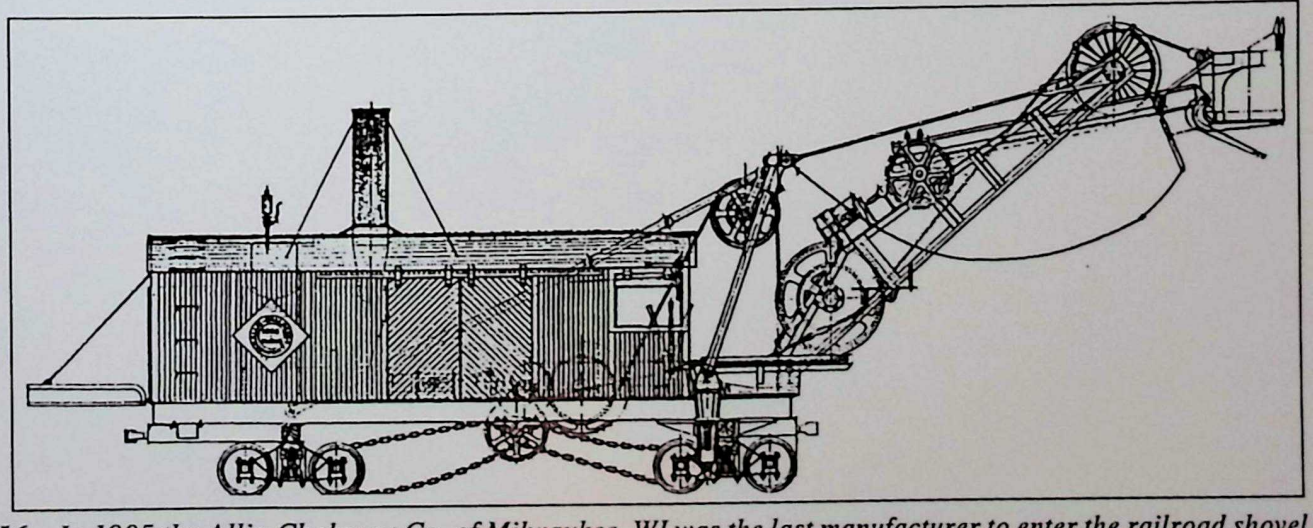
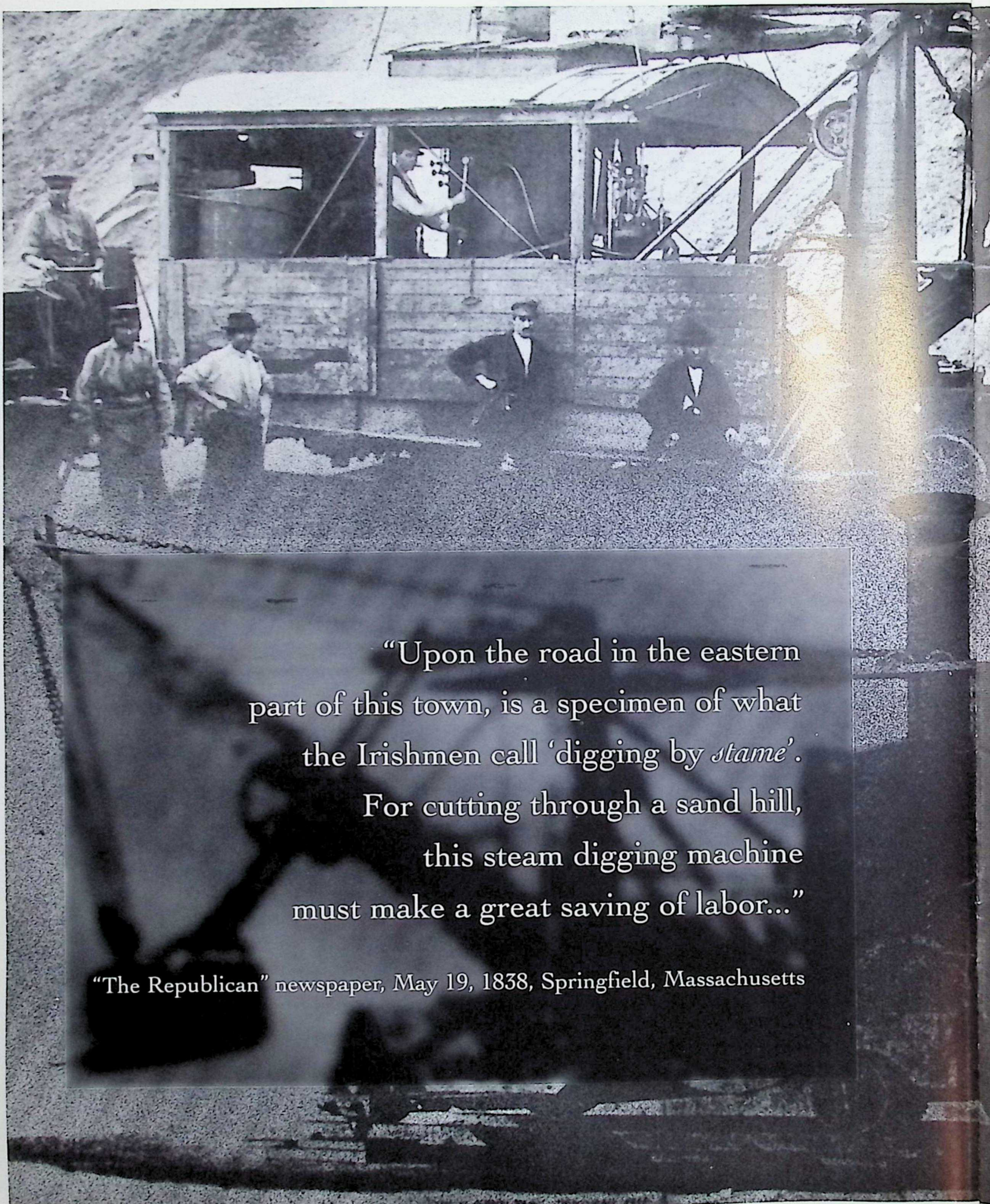
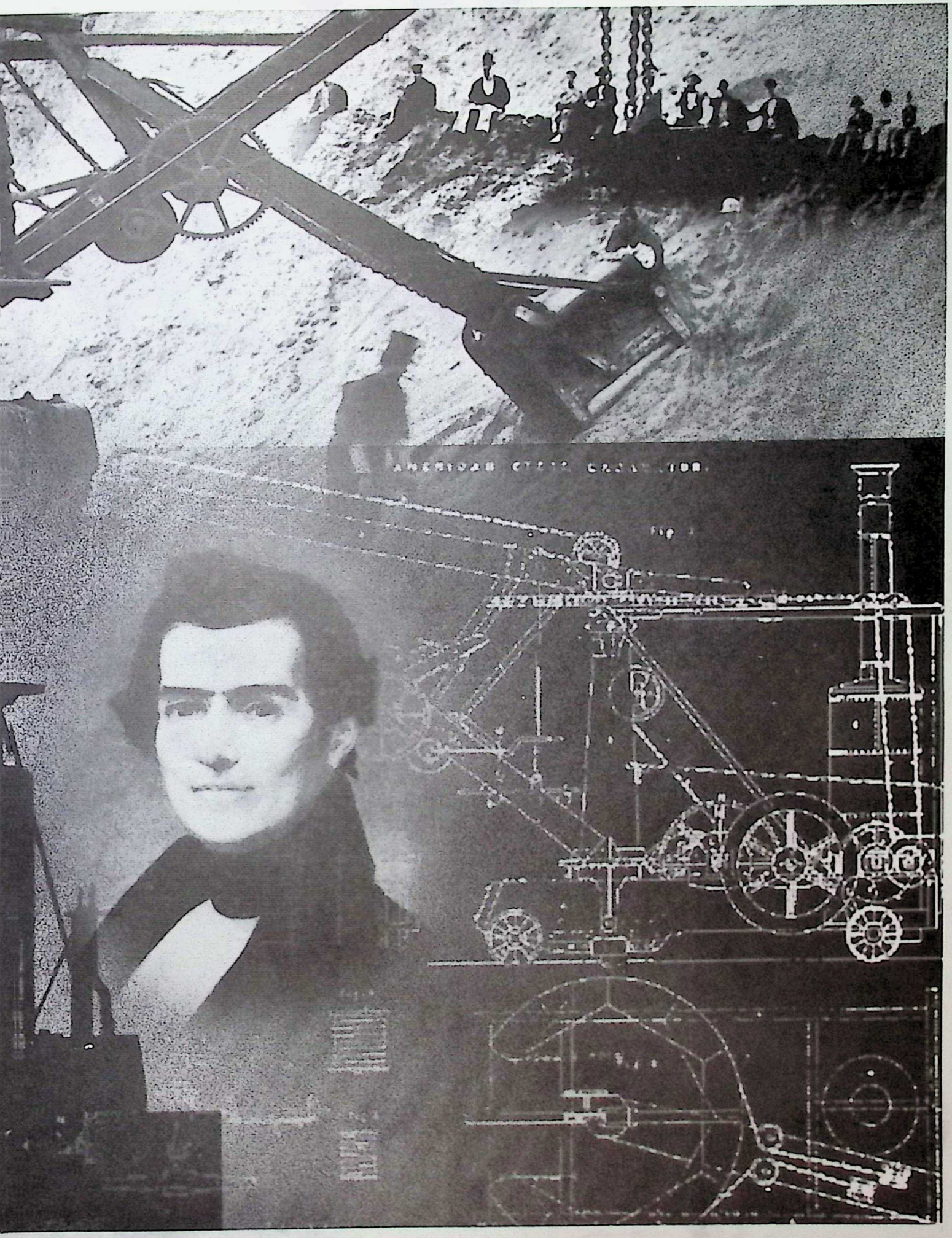


Photo 16 *In 1905 the Allis-Chalmers Co. of Milwaukee, WI was the last manufacturer to enter the railroad shovel market. Although their machines were of an exceptionally heavy construction, Allis-Chalmers discontinued shovel manufacturing in 1908, reportedly after building only 16 machines.*



"Upon the road in the eastern
part of this town, is a specimen of what
the Irishmen call 'digging by *steame*'.
For cutting through a sand hill,
this steam digging machine
must make a great saving of labor..."

"The Republican" newspaper, May 19, 1838, Springfield, Massachusetts



PROPERTY OF
CANTON HISTORICAL SOCIETY
BY _____
DATE _____

Please credit
Canton Historical Society
for use of material

2024.1229.3